E/M Radiation from the Sun

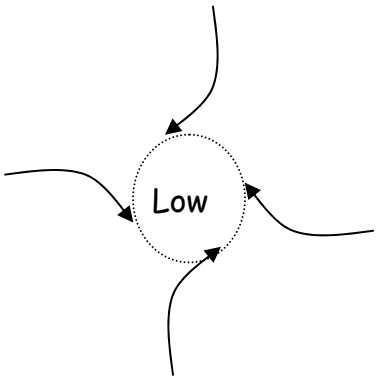
The sun produces a whopping 4×10^{26} watts of e/m energy. Most if this is visible light. At 1 AU from the sun earth intercepts about 1400 watts per square meter.

- Energy in the sun is created in the thermonuclear core and is transmitted outward to the surface of the sun (the *photosphere*) via radiation and convection.
- The sun is a blackbody whose surface temperature may be determined from its color via Wiens Law (about 5800K).
- The sun pumps out an amazing 4×10^{26} watts of power. This energy is radiated away from the sun in all directions.
- Energy from the surface of the sun reaches the top of the earth's atmosphere via electromagnetic radiation (sunlight). Due to the inverse square law, the amount of power from the sun which reaches the top of earth's atmosphere is about 1400 watts/m^2.
- Earth's atmosphere generally absorbs very little sunlight. About 1000 watts/m^2 of power from the sun eventually reaches the earth's surface in the middle latitudes (under ideal conditions).
- Since the atmosphere is nominally transparent to visible light it is the presence of aerosols and clouds that reflect and scatter the 30% of sunlight that does not penetrate the atmosphere.
- The average amount of sunlight that reaches the earth's surface worldwide is about 340 w/m^2.
- Of the sunlight that reaches the earth's surface, approximately 1/3 is absorbed and converted to IR (blackbody effect) – about 110 watts/m^2. The remaining sunlight is reflected/scattered back into the atmosphere from the earth's surface.
- The earth warms all during the day (while it is being illuminated) and radiates well after sunset.
- Earth's atmosphere absorbs and scatters IR (the greenhouse effect), thus heating the environment. Greenhouse gasses include water vapor, carbon dioxide and methane.
- The atmosphere is also heated by conduction in the *boundary layer*. The boundary layer is the layer of air within a meter of so of the ground. Although air is generally not a good conductor of heat, the amount of air in contact with large patches of ground eventually becomes heated due simply to the large areas involved.
- On a warm sunny day temperature gradients in the boundary layer can be as great as 40^0 F in less than a meter!
- Warm air is less dense than cool air, is more buoyant, and will rise. On clear, calm days thermal bubbles of warm air rise over portions of the earth's surface warmed by direct sunlight.
- These thermal bubbles contain air and water vapor. As they rise they cool at approximately the lapse rate of 5.5^0 F per 1000 feet in the troposphere. As they

cool the water vapor in these air masses condenses to water droplets. This begins the process of cloud formation.

- Condensation liberates *latent heat.* The release of latent heat is a significant contributor to Earth's overall temperature. Latent heat is also a significant energy source for thunderstorms as the release of latent heat from condensation enhances thermal activity and results in large amounts of vertical air movement in the atmosphere. Hurricanes are examples of large weather systems fueled by the release of latent heat.
- Thermal activity in Earth's atmosphere distributes heat from the sun vertically and from the equatorial regions northward where warming of the surface is less efficient.
- Vertical motion of air creates High and Low Pressure regions. Horizontal movement of air both near the surface and at higher elevations creates fronts, long waves, and jet streams. All of these features distribute heat throughout the atmosphere.
- Most large (mesoscale or greater) weather systems rotate due to the *Coriolis Force.* The Coriolis force is an apparent deflection to the right that affects all air masses due to the rotation of the earth.

High and low pressure systems



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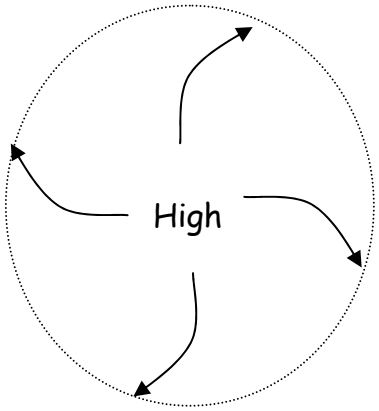

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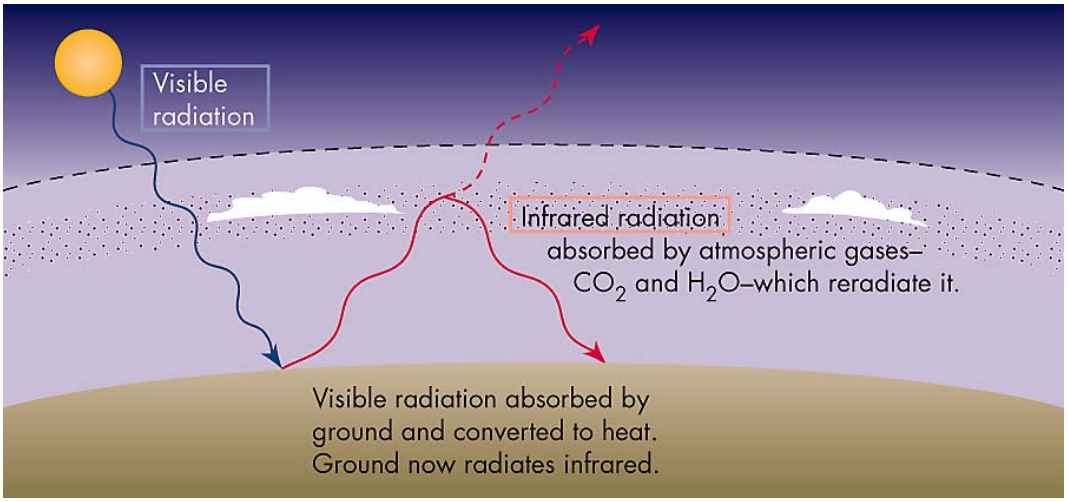
Greenhouse Effect

- Earth, Venus, Mars all have greenhouse gasses in their respective atmospheres
- A greenhouse effect, due to the partial opacity of the atmosphere to infrared light, helps moderate temperature on earth.



- Although Earth has always had a "greenhouse effect", human activities are increasing both the amount of greenhouse gasses in Earth's atmosphere and the infrared signature of Earth's surface, thus enhancing the existing greenhouse effect
- Global warming is a well-established scientific fact
- Increasing CO_2 levels (and other greenhouse gasses) have been thoroughly documented.
- Increase of Earth's infrared signature has been thoroughly documented
- Increasing global temperatures have been thoroughly documented