

# Energy Transfer AOSC 200

Tim Canty

Class Web Site: <http://www.atmos.umd.edu/~tcanty/aosc200>

Topics for today:

- Layers of the Atmosphere
- Energy transfer
- Energy Spectrum

## Lecture 07 Sep 17 2019

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### Atmospheric temperature

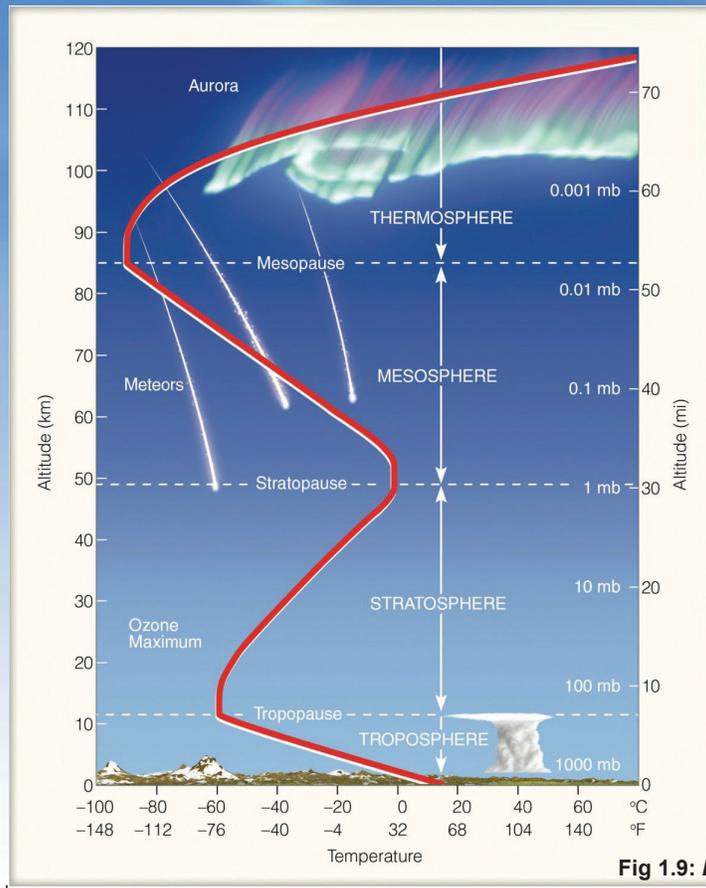


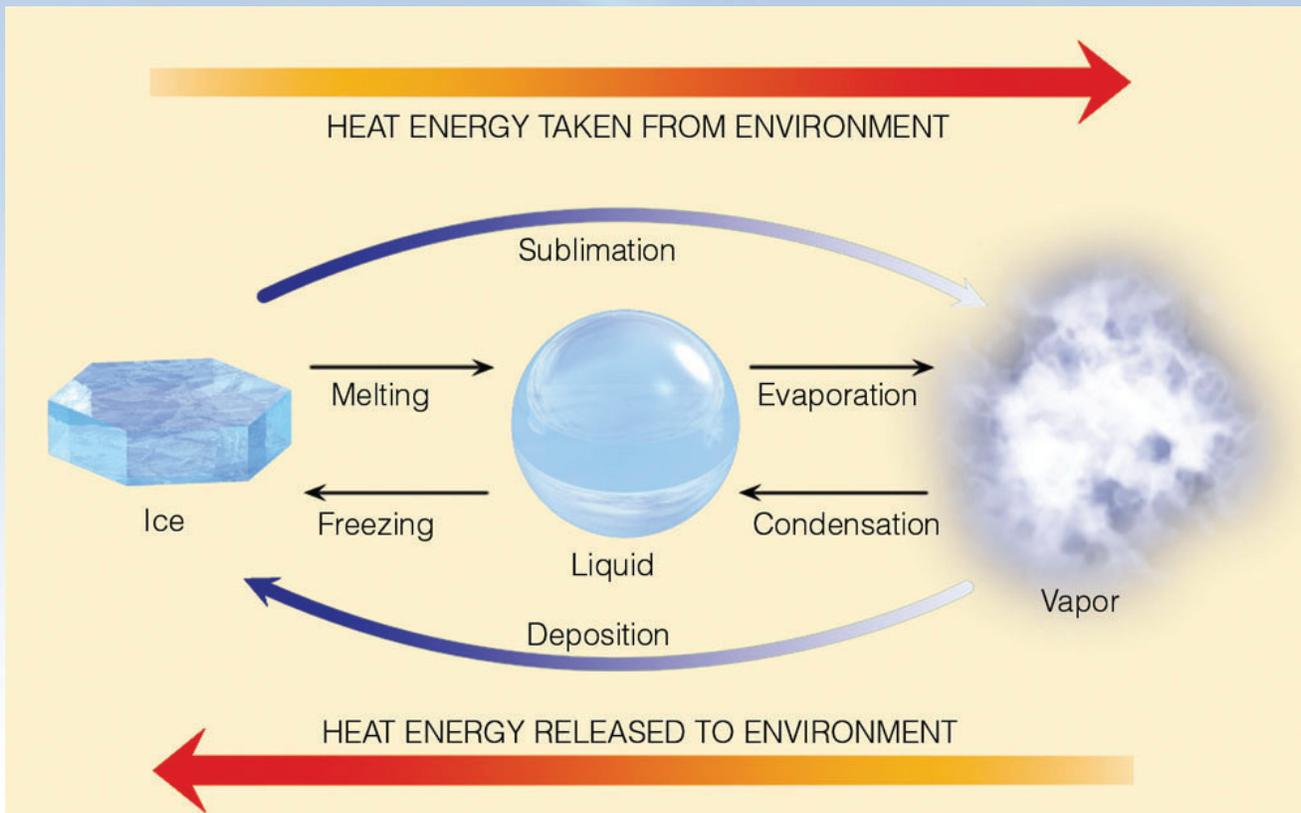
Fig 1.9: *Essentials of Meteorology*

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## Energy Transfer



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Fig 2.3: *Essentials of Meteorology*

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## Energy Transfer: Conduction

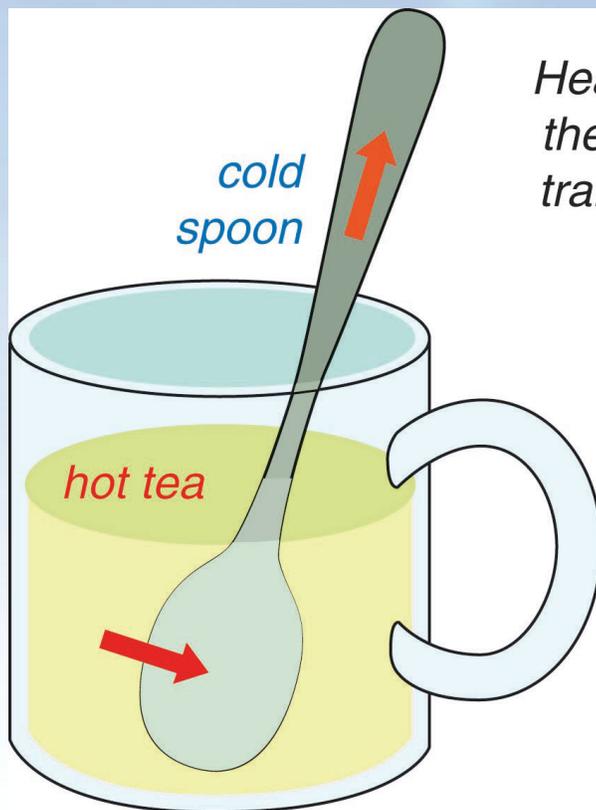
- **Conduction – requires contact, energy transferred from molecule to molecule**
- **Air is not a good conductor**
- **Metals are excellent conductors**
- **Very important at Earth's surface**

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## Energy Transfer



*Heat is conducted up the spoon handle by transfer of molecular vibrations.*

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**Fig 4.1 Weather: A Concise Introduction** 5

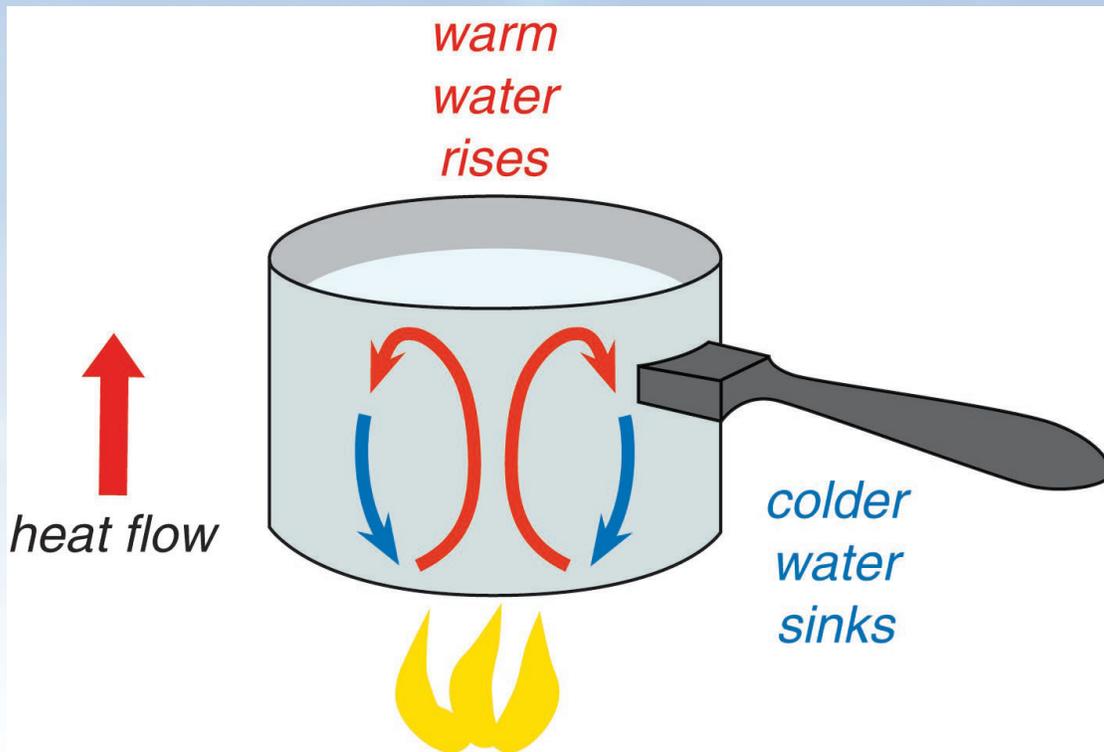
## Energy Transfer: Convection

- **Convection – energy transferred by vertical movement of fluids (air is considered a fluid)**
- **Surface energy transferred upward by convection**
- **“Hot air rises and cool air sinks”**
- **Lava lamps are a good example of convection**

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## Energy Transfer: Convection



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Fig 4.2 *Weather: A Concise Introduction* 7

## Temperature and Density

### Ideal Gas Law

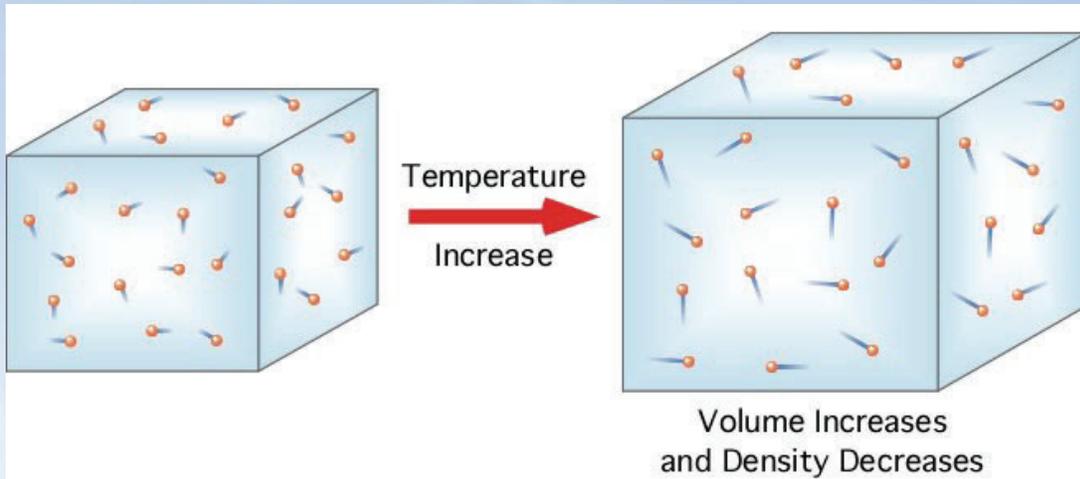
$$\text{pressure} = \text{density} \times \text{temperature} \times \text{constant}$$

$$\text{density} = \frac{\text{pressure}}{\text{temperature} \times \text{constant}}$$

**As temperature rises, density falls**

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## Temperature and Density



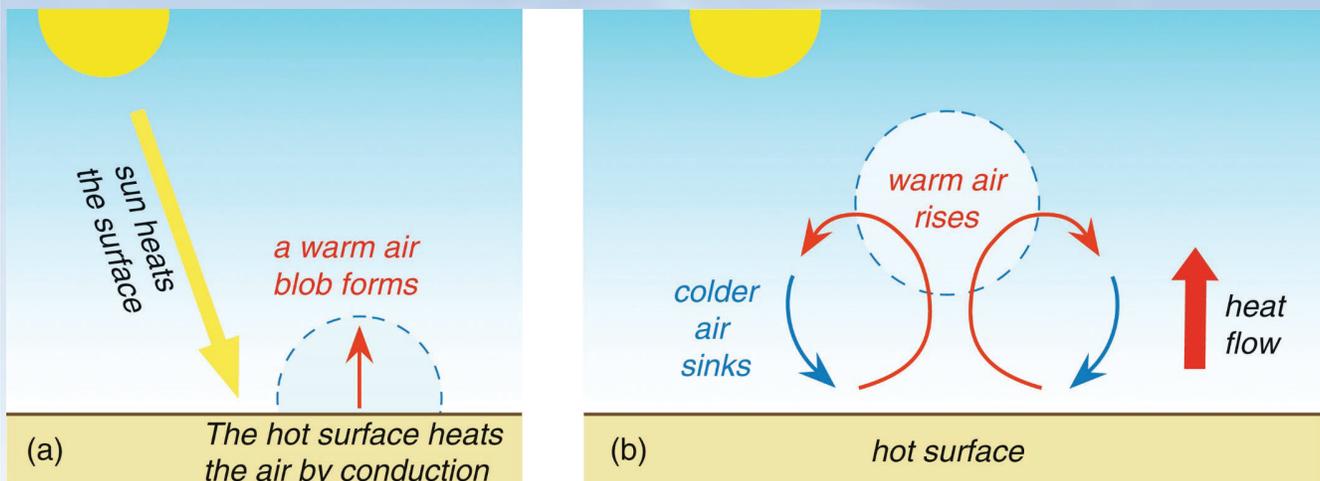
**As temperature rises and the parcel expands.  
This is called thermal expansion.**

**The air inside the parcel gets less dense**

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<http://www.our-planet-earth.net/learning/3c.html>

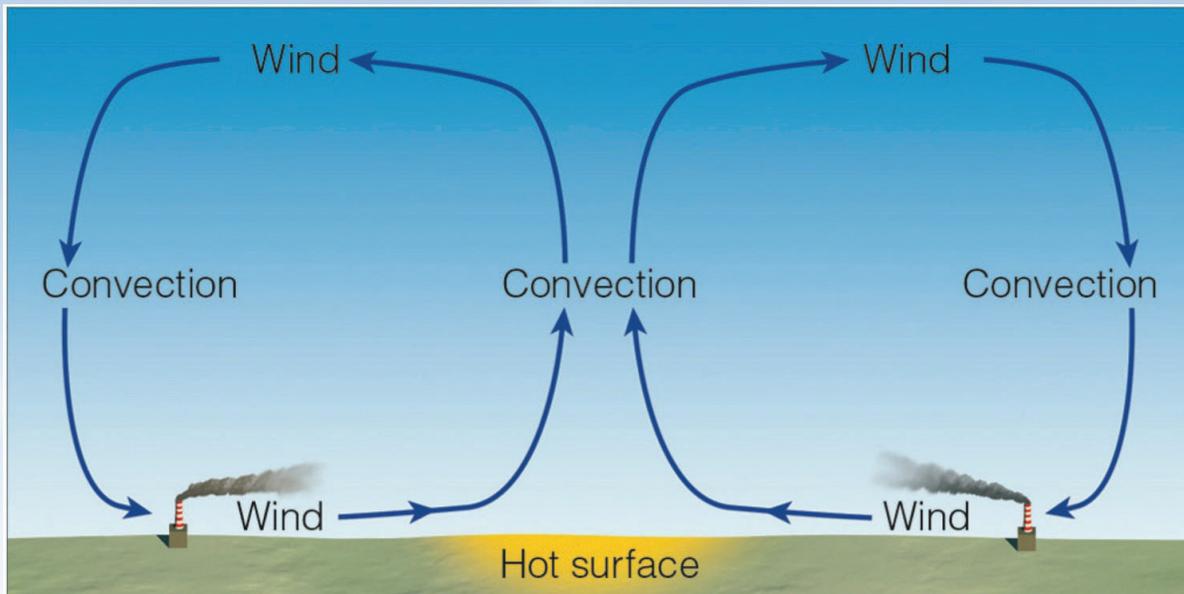
## Energy Transfer: Convection



**Note: The pressure in the “blob” is the same as the surrounding air pressure**

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## Energy Transfer: Convection



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**Rising, hot air creates convective circulation**

**Thermals will eventually spread out, sink and move back to the starting point creating wind**

Fig 2.7: *Essentials of Meteorology*

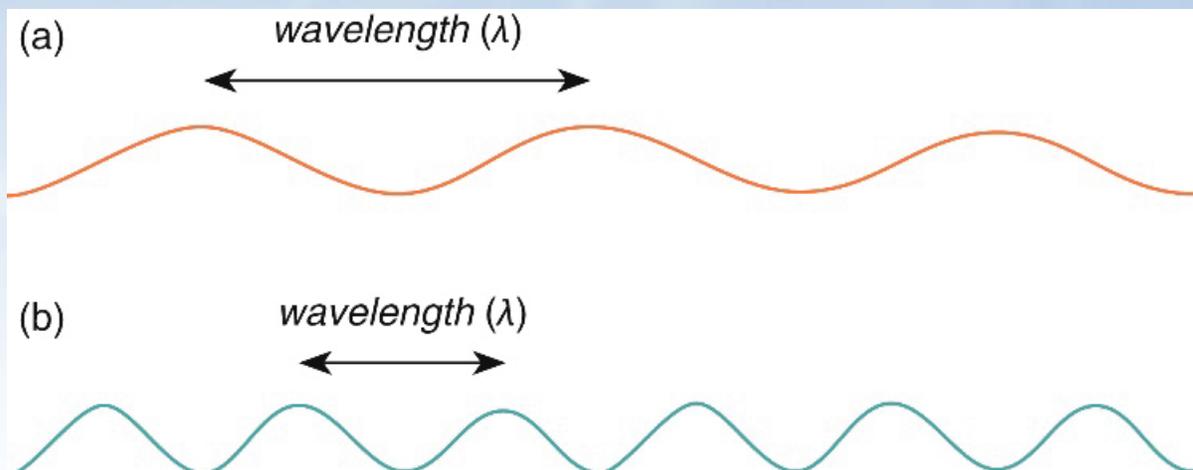
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## Energy Transfer: Radiation

**Radiative Heat – heating due to electromagnetic radiation (waves of energy that move through space)**

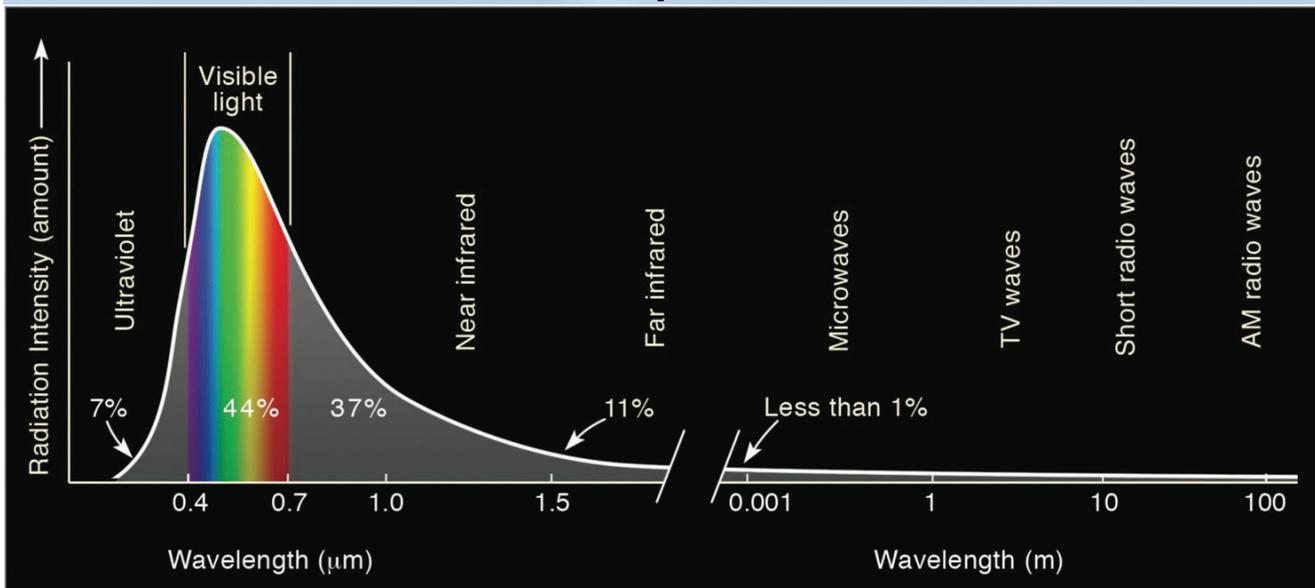


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Fig 4.4 *Weather: A Concise Introduction* 12

# Solar Spectrum



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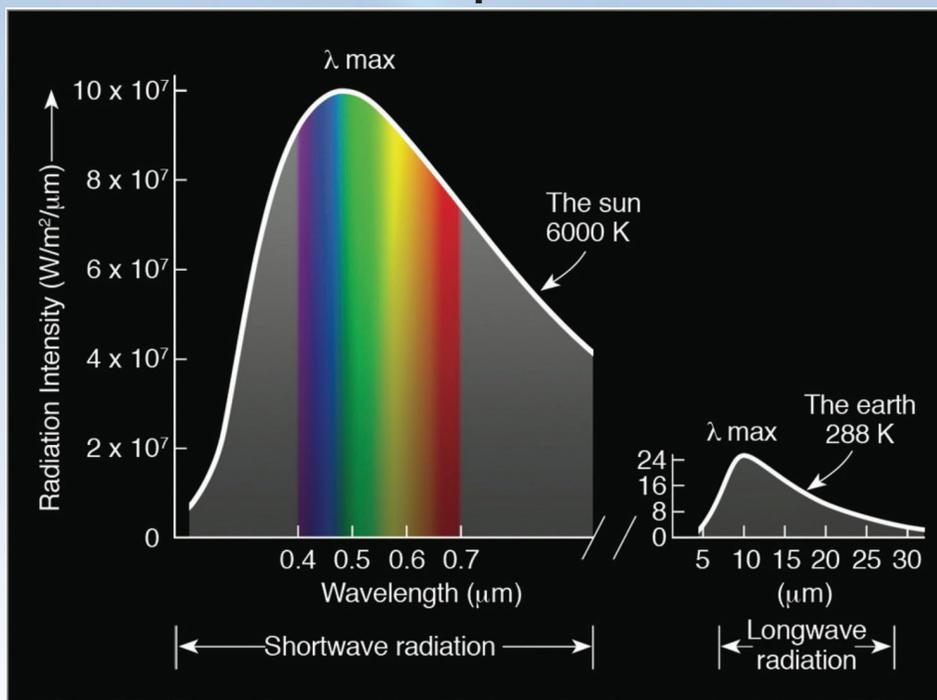
**The energy from the Sun peaks at 0.5 μm (the visible portion of the spectrum)**

Fig 2.9: *Essentials of Meteorology*

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# Solar Spectrum



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**The energy from the Sun peaks at 0.5 μm (the visible portion of the spectrum)  
The energy from the Earth peaks at 10 μm (in the infrared portion)**

Fig 2.10: *Essentials of Meteorology*

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## Energy Transfer: Radiation

**Radiative Heat – heating due to electromagnetic radiation (waves of energy that move through space)**

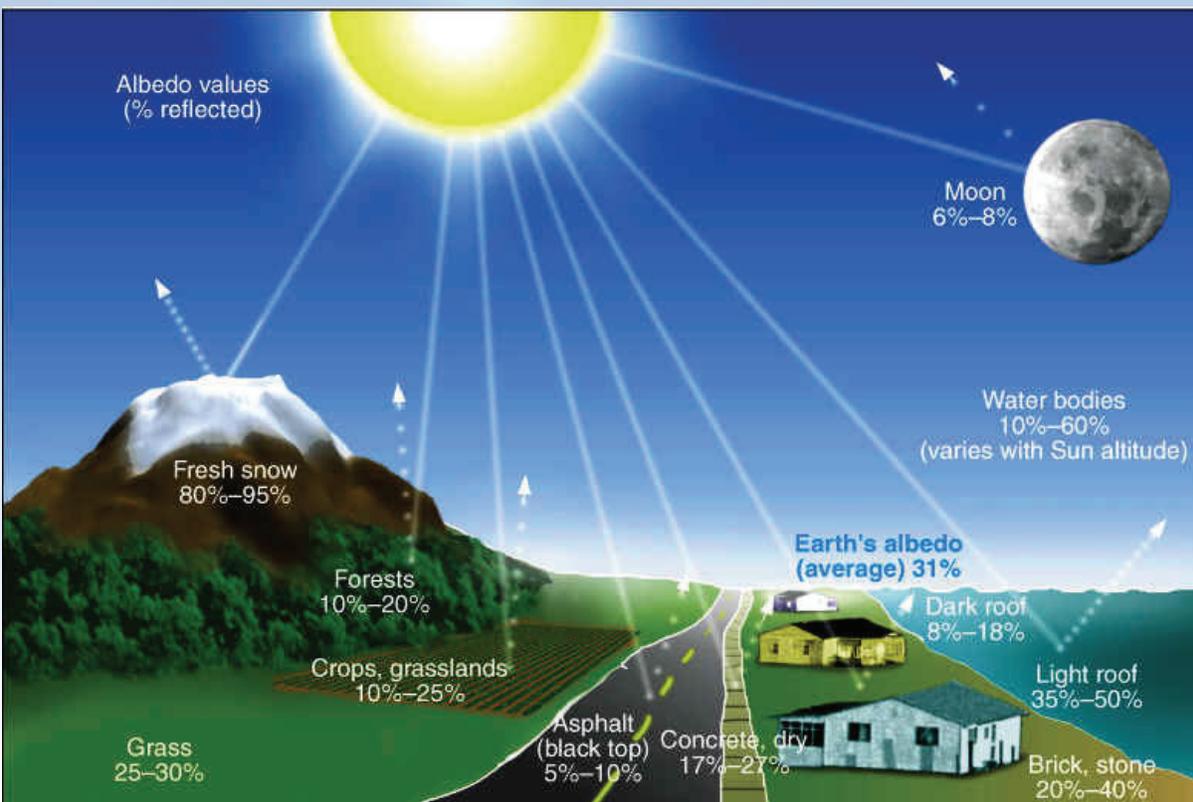
**Can be:**

- **Absorbed**
- **Reflected**
- **Scattered**

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**Fig 4.4 Weather: A Concise Introduction** 15



[http://marineecology.wcp.muohio.edu/climate\\_projects\\_04/snowball\\_earth/web/WebpageStuff/albedo.html](http://marineecology.wcp.muohio.edu/climate_projects_04/snowball_earth/web/WebpageStuff/albedo.html)

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## Reflection: Albedo

**Albedo – the percentage of radiation that is reflected off of a surface**

**100% means everything is reflected**

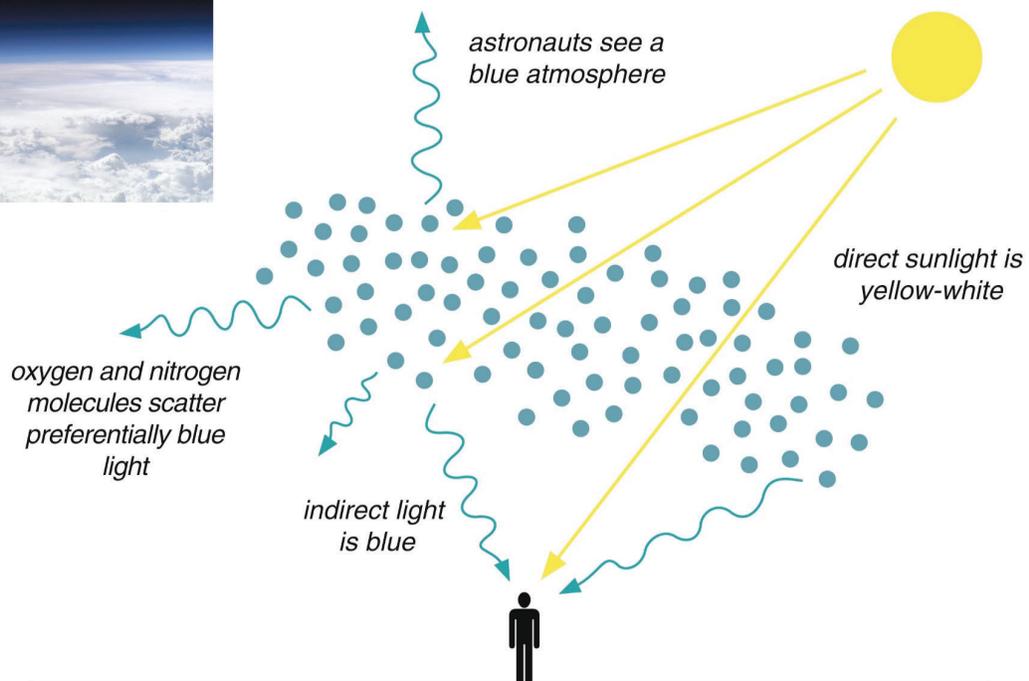
**Snow has an albedo of 90%**

**Overall, the Earth's albedo is 30%**

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## What color is the sky?

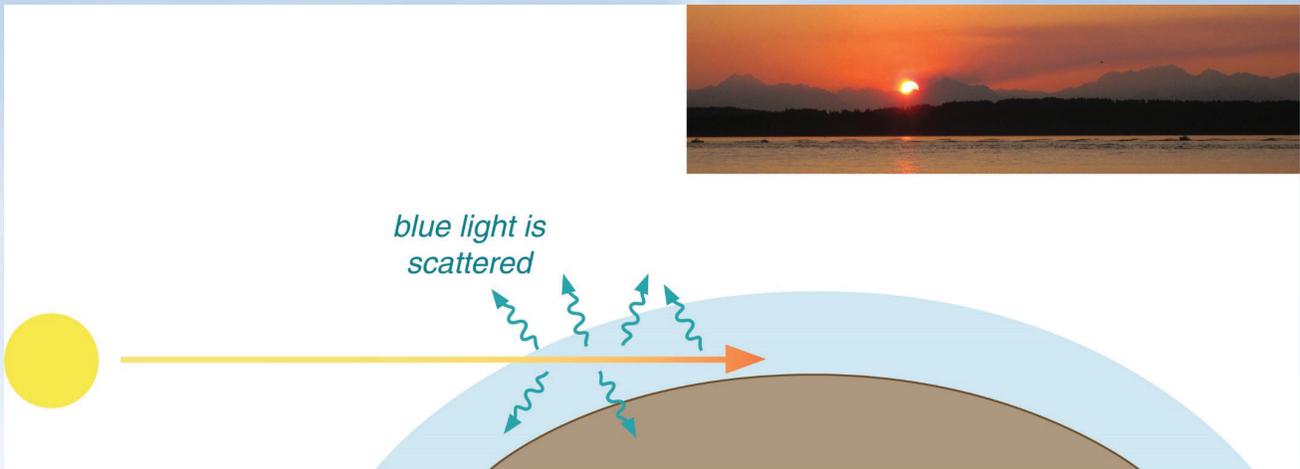


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Fig 4.2.1 *Weather: A Concise Introduction*

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# What color is the sky?



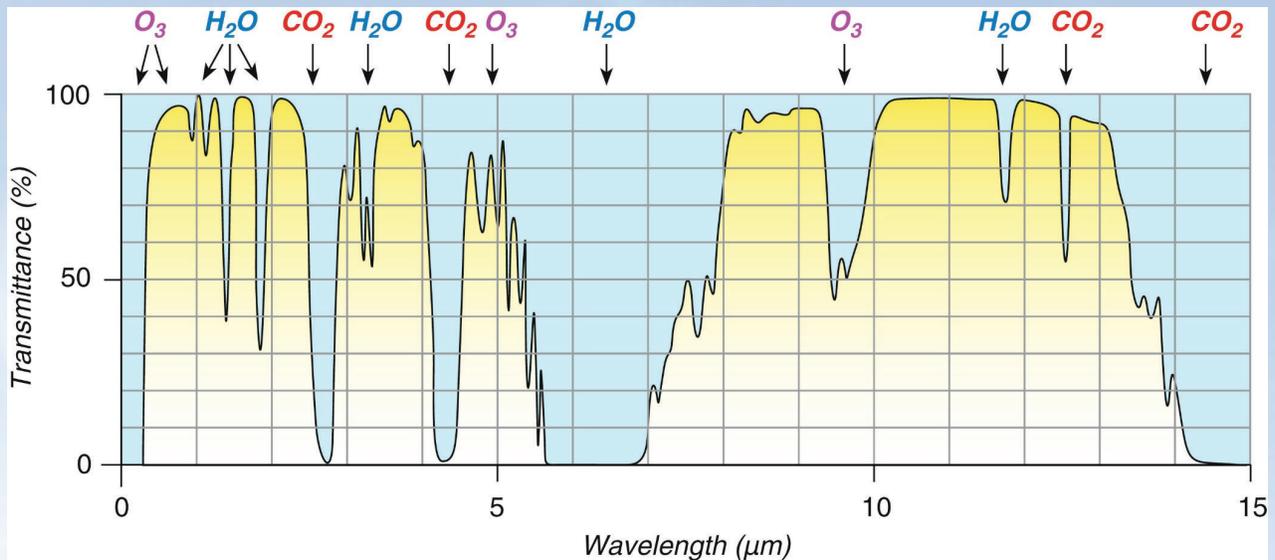
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Fig 4.2.2 *Weather: A Concise Introduction*

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# How does energy interact with the atmosphere?



**The atmosphere absorbs energy only at certain wavelengths and transmits at others**

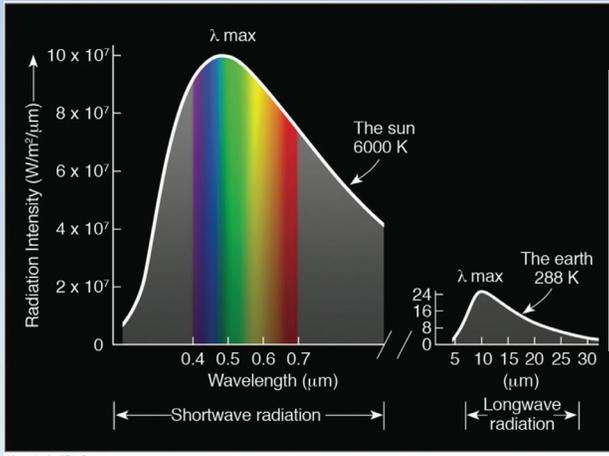
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Fig 4.6 *Weather: A Concise Introduction*

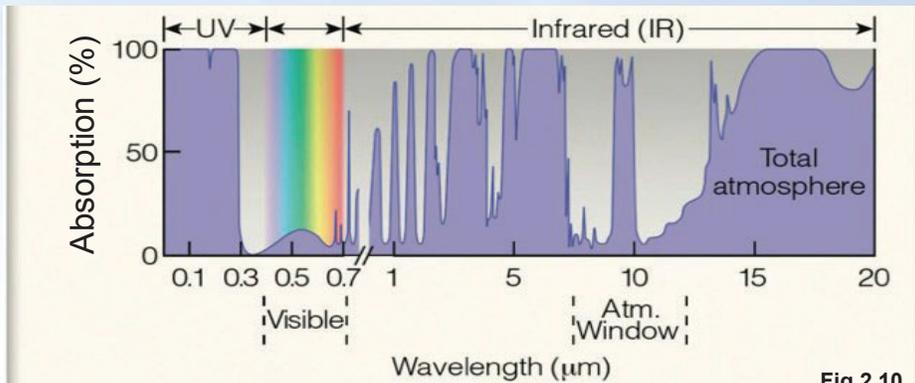
20

# Atmospheric Absorption



The Sun releases energy at shorter wavelengths (UV, visible, near-infrared)

The Earth releases energy at longer wavelengths (IR)



Absorption is the opposite of transmittance

Fig 2.10, 11: *Essentials of Meteorology*

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# Atmospheric Absorption

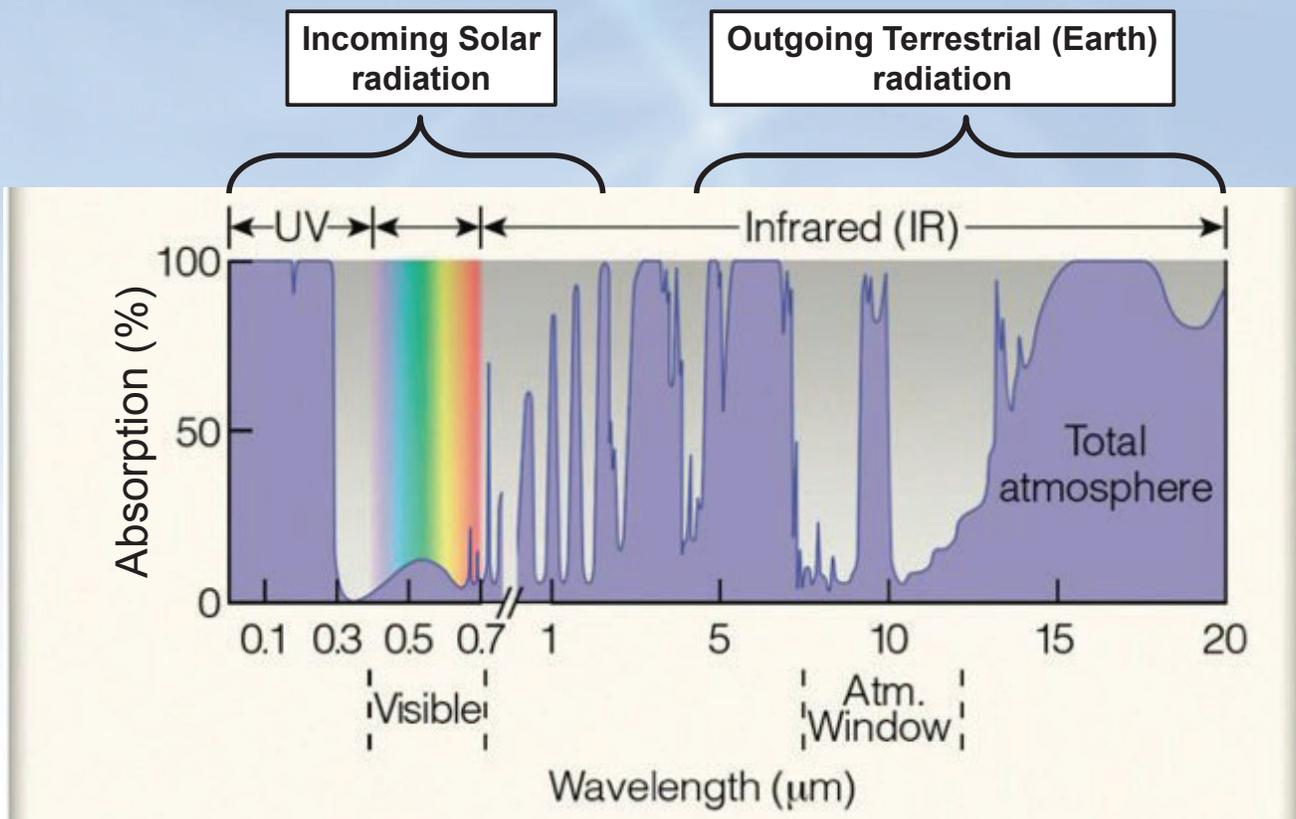


Fig 2.11: *Essentials of Meteorology*

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# Atmospheric Absorption

This slide shows how much radiation is absorbed by the atmosphere at different wavelengths.

Example, at 0.1  $\mu\text{m}$  the atmosphere absorbs 100% of the incoming radiation from the sun.

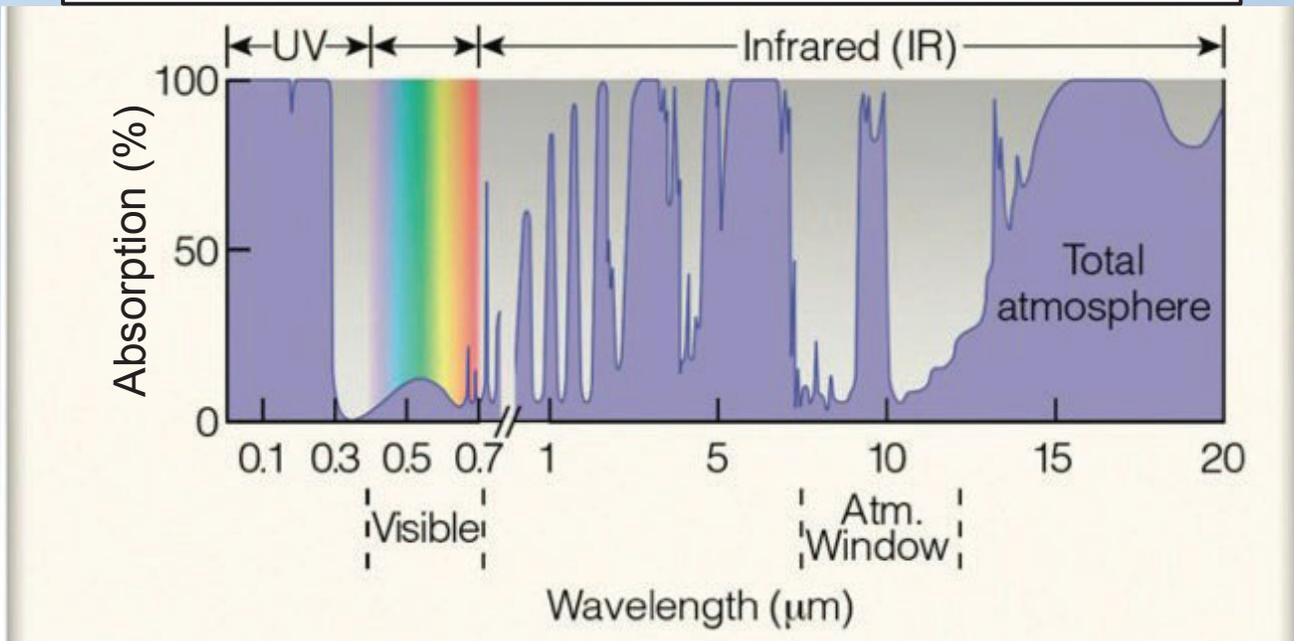


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## Atmospheric Absorption from $\text{O}_2$ and $\text{O}_3$

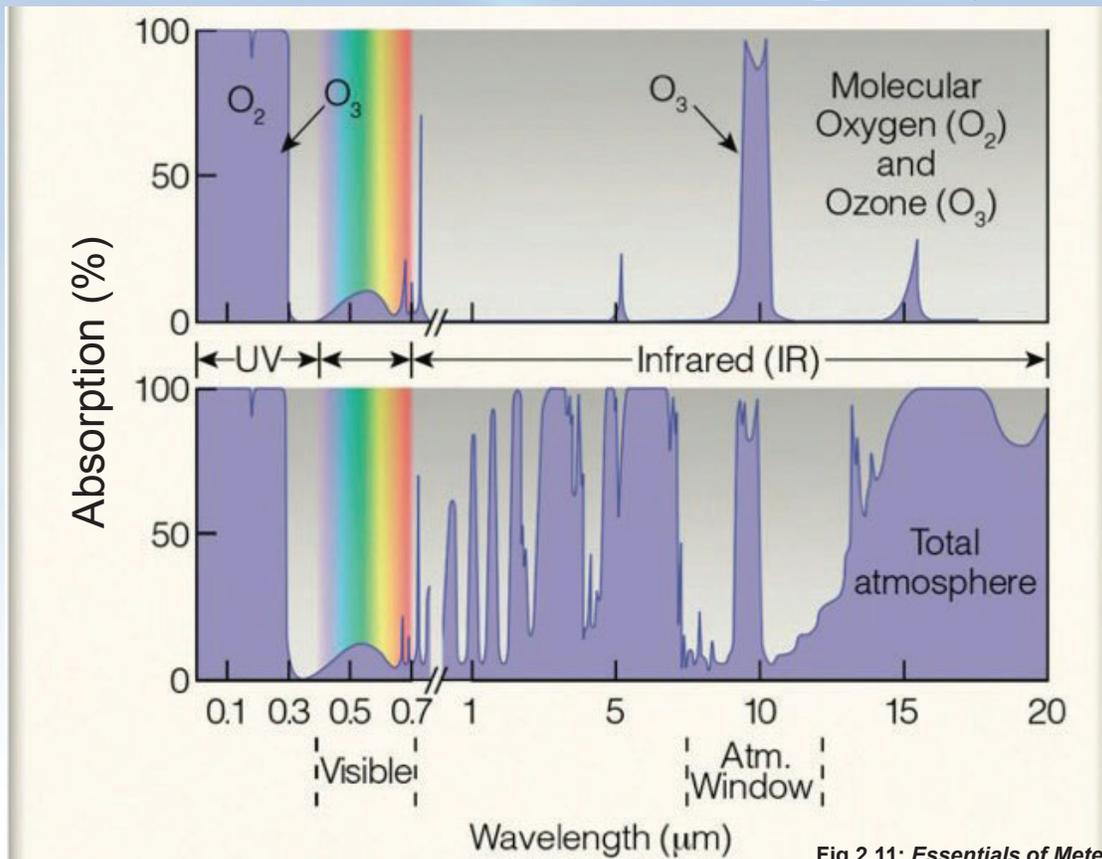


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## Atmospheric Absorption from CH<sub>4</sub>

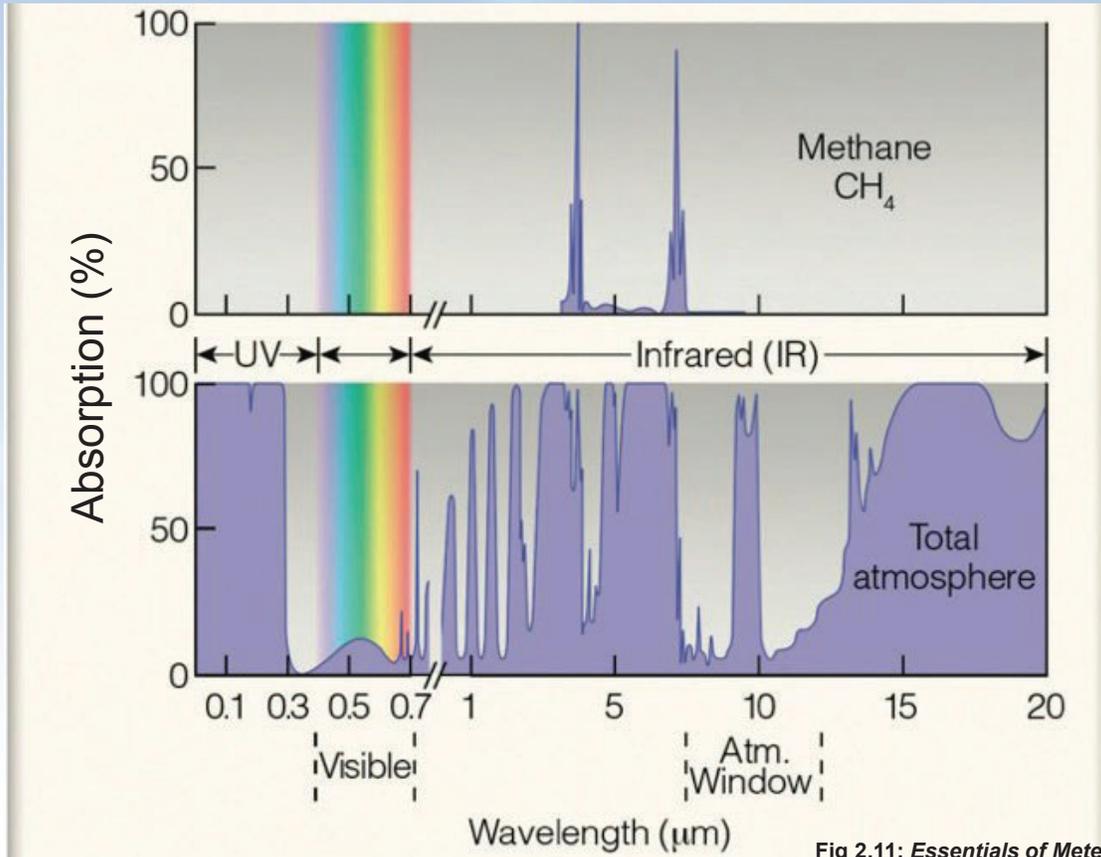


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## Atmospheric Absorption from N<sub>2</sub>O

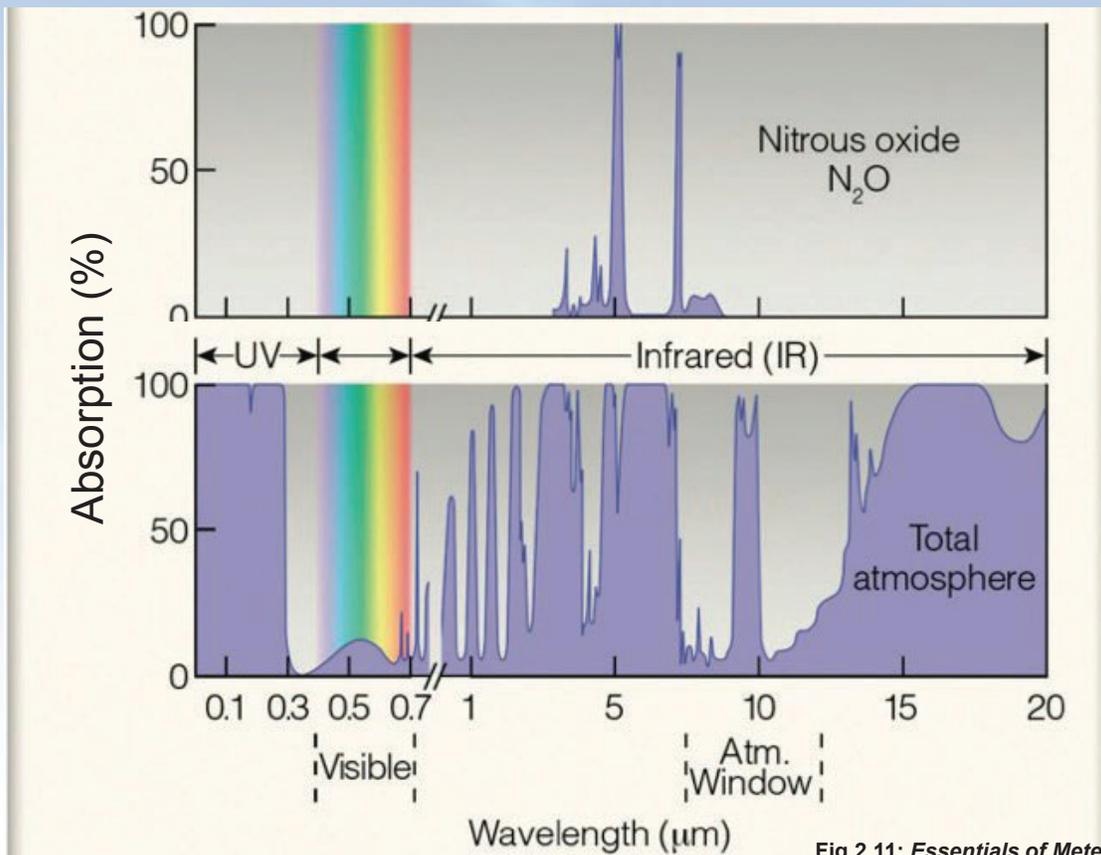


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## Atmospheric Absorption from CO<sub>2</sub>

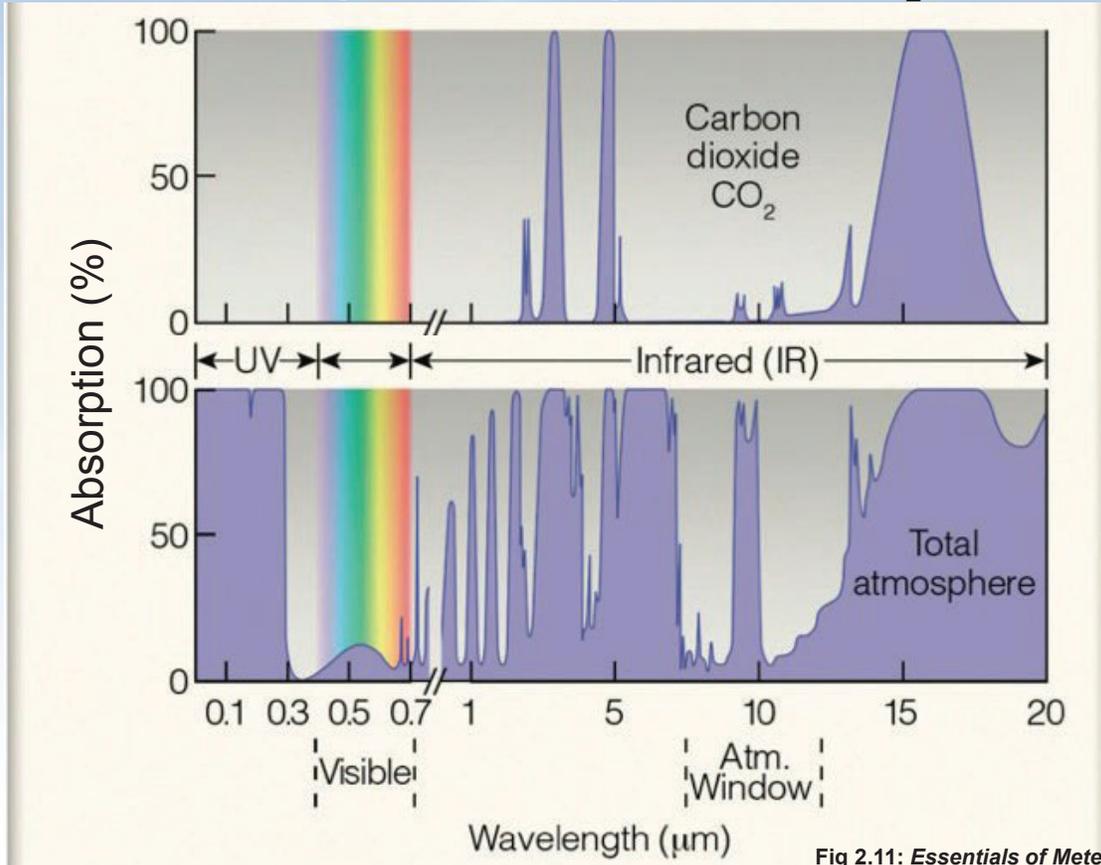


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## Atmospheric Absorption from H<sub>2</sub>O

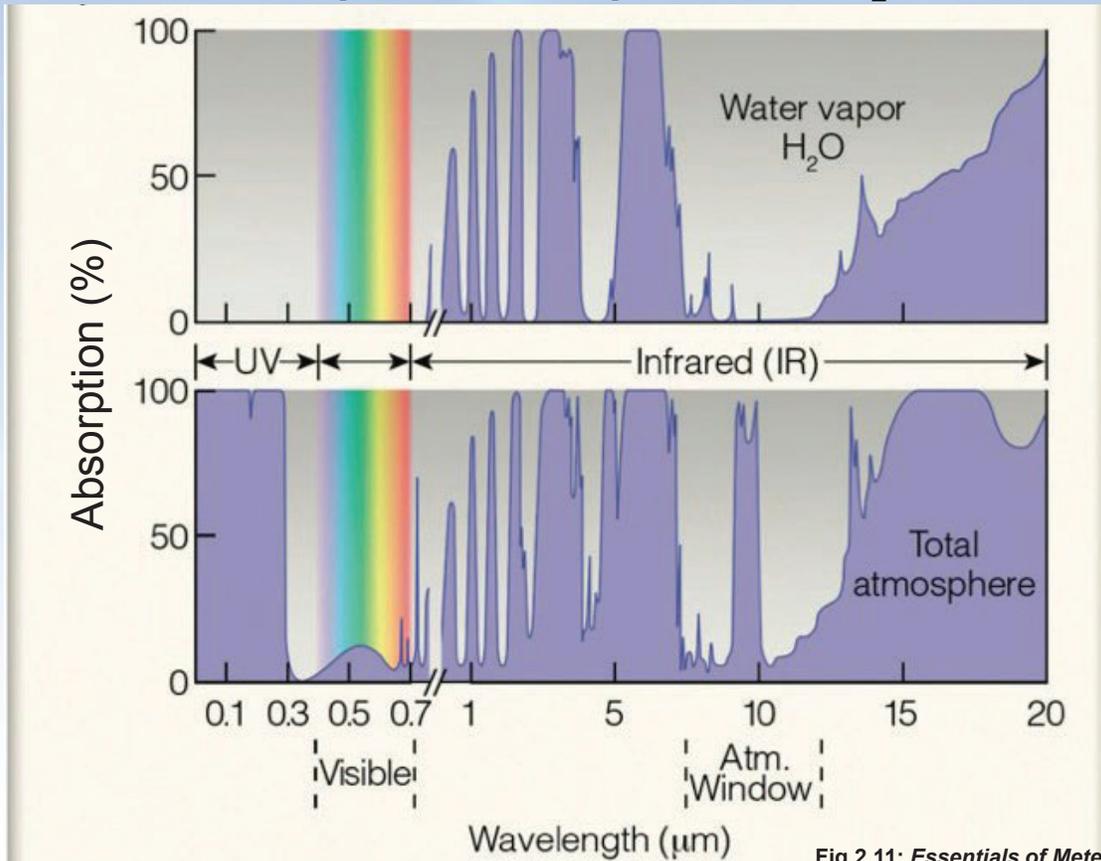


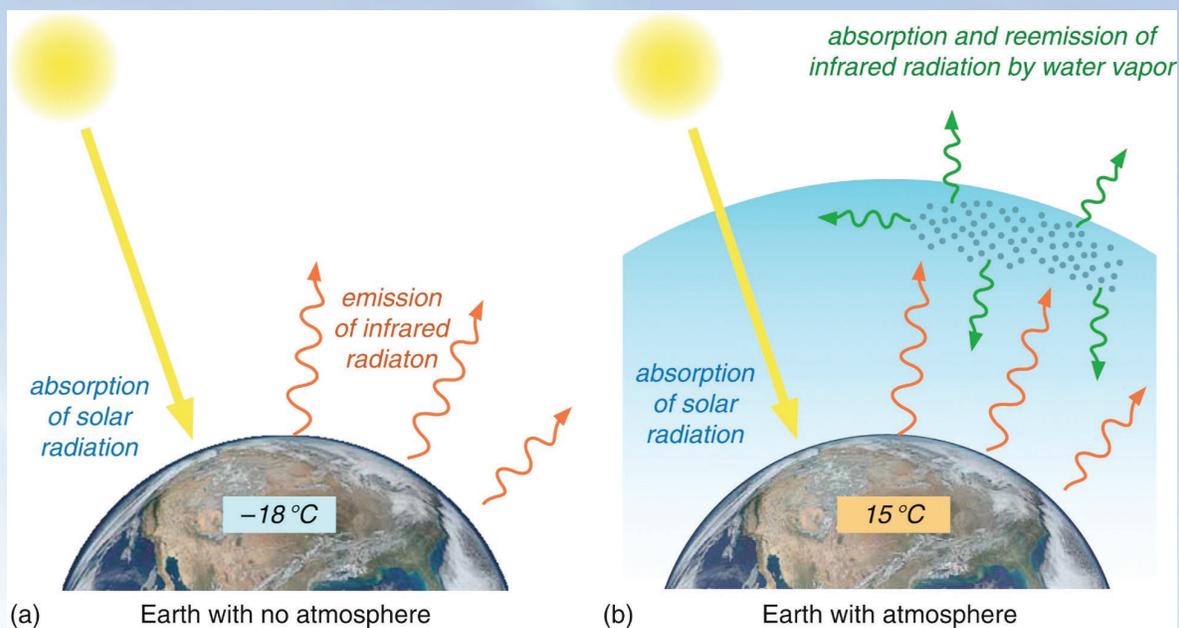
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# Earth with the Greenhouse Effect



**What happens when the “blanket gets too thick?”**

Fig 4.7: *Weather: A Concise Introduction*