Atmospheric Influences on Radiation

Topics:
1. Reflection and Scattering
   a. Rayleigh Scattering
   b. Mie Scattering
2. Absorption
3. Transmission
4. Atmospheric Window
5. Greenhouse Effect

Readings
A&B: Ch 3. (p. 56-68)

Atmospheric Reflection and Scattering

Reflection:
Scattering:

Specular Reflection (Mirror)
Diffuse Reflection or Scattering

Two types:
Rayleigh Scattering

• **Rayleigh Scattering**: ____________ tend to scatter __________________ more, and in ____________

• The blue end of the visible range is preferentially scattered

![Diagram of Rayleigh Scattering]

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Rayleigh Scattering

• Near sunrise or sunset
• Radiation must traverse a longer pathlength
• More short wavelengths (blue light, as well as green light)

• Light that is transmitted to the surface is mostly

![Diagram showing scattering at different times of day]

(a)

(b)

(c)
Mie Scattering

- **Mie Scattering**: ________________ tend to scatter __________ equally, and more __________________________
- Both scattered and transmitted light are a mixture of all wavelengths: white light
  → Clouds and fog appear as white, gray or milky
  
  → On hazy polluted days: all wavelengths are scattered by particles

Atmospheric Absorption

- Absorbed radiation is converted to heat →

- **Selective absorption**: the absorptivities ($\alpha_{\lambda}$) of atmospheric gases are

  - Solar radiation (shortwave) absorbers:
    - UV-absorbers: ozone (O$_3$), oxygen (O$_2$)
    - Visible range (0.4 - 0.7 µm): absorption by clouds, almost no absorption by gases (→ window)
  - Terrestrial radiation (longwave) absorbers:
    - IR absorbers: greenhouse gases (H$_2$O, CO$_2$, N$_2$O, O$_3$)
    - Peak terrestrial radiation (8 - 12 µm): absorption by clouds, almost no absorption by gases (→ window)

- The atmosphere is __________________________
  __________, but __________________________
Atmospheric Transmission

- **Transmission**: the amount of radiation that is left, after going through the atmosphere

Atmospheric Windows

- **Atmospheric Window**:
  - Note: The atmospheric window is NOT a place
  - There are two atmospheric windows:

- **Visible range window (0.4 - 0.7 µm)**:
  - Most solar radiation penetrates to the surface
  - Most of the energy from the sun is available at the surface for use in climate processes
  - May be “closed” by clouds and/or aerosols
    - Reduction of energy input into E/A system
    - Cooling effect
Atmospheric Windows

• *Longwave window (8 - 12 µm)*:
  ▪ Some terrestrial radiation penetrates to space
  ▪ Enables Earth to “vent off” some of its energy back to space
  ▪ May be “closed” by increased H₂O, CO₂, or other greenhouse gases, or by clouds
    • Increase infrared absorption by the atmosphere
    • Warming
      → The Greenhouse Effect

The Greenhouse Effect