In this course...

I. Brief introduction to the atmosphere
II. Overview of the Earth System
III. Survey of the atmosphere:
    1. Dynamics
    2. Thermodynamics
    3. Weather systems: Extratropical
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    7. Radiative transfer
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    9. Weather Systems: High latitude and tropical
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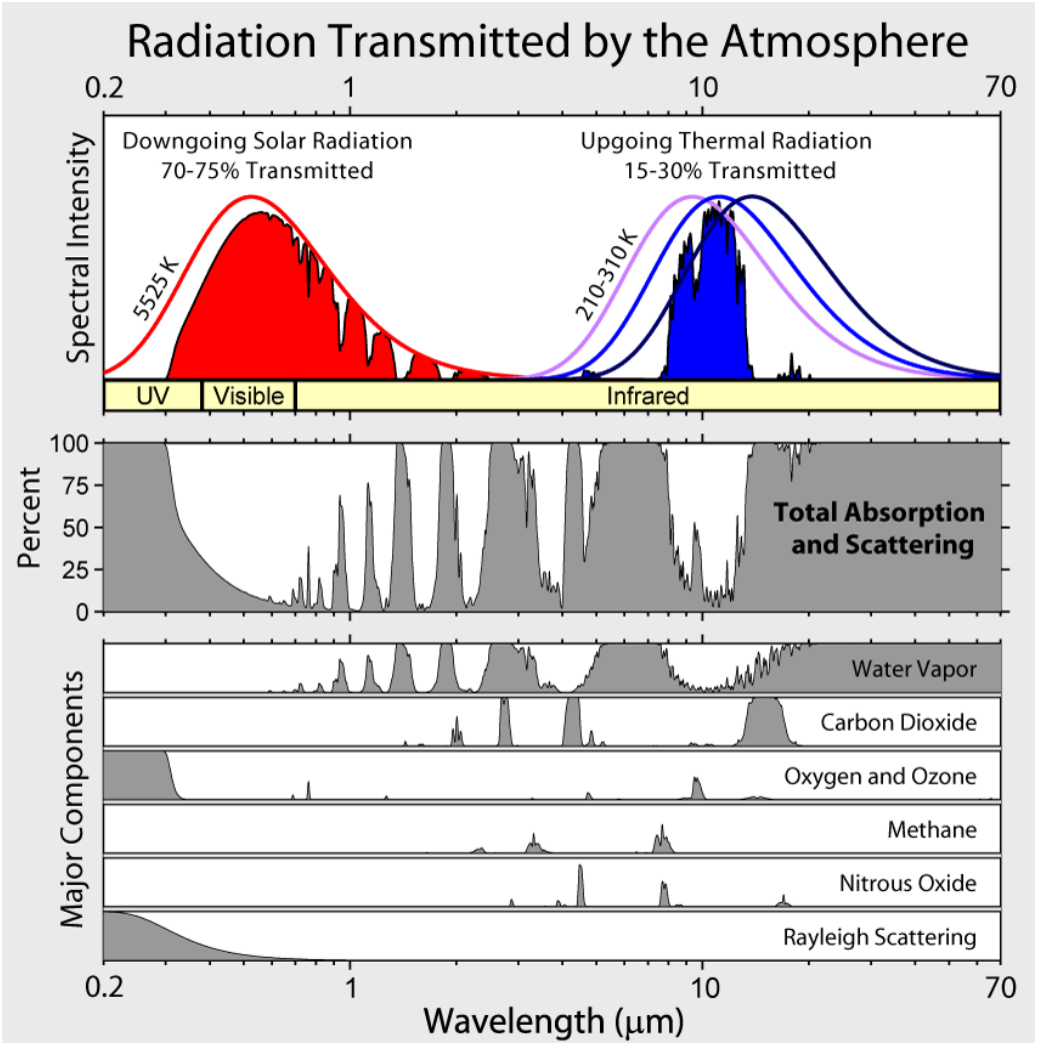
IV. Useful research tools in atmospheric science

Radiative transfer

I. Concepts, definitions, units
II. Thermal infrared radiation transfer
III. Solar radiation transfer
IV. Principles of radiative transfer in atmosphere

Radiative transfer



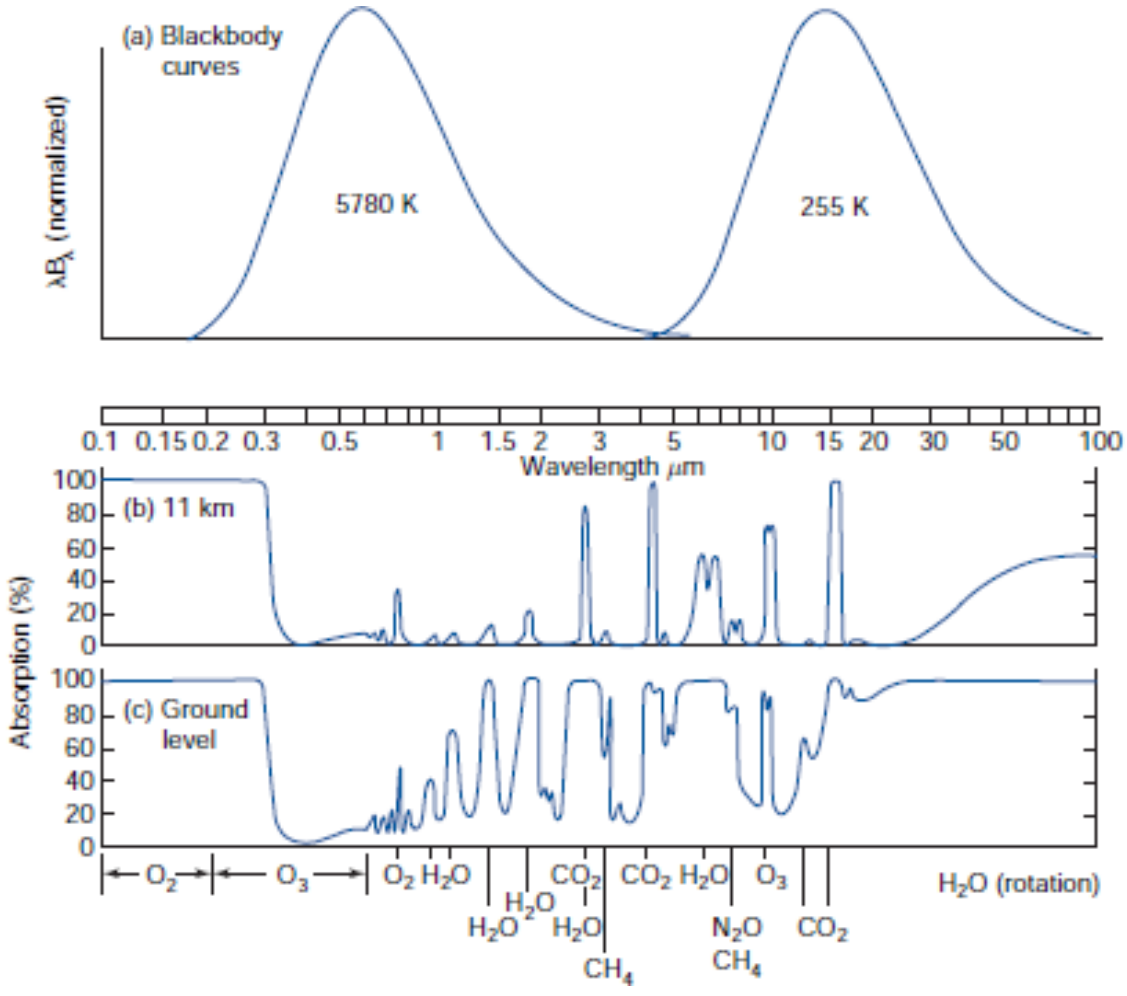
Most ($\sim$70-75%) solar radiation is transmitted (atmosphere is 'transparent' to solar radiaton)

Ozone is good absorber of UV radiation, H_2O vapor absorbs some solar radiation

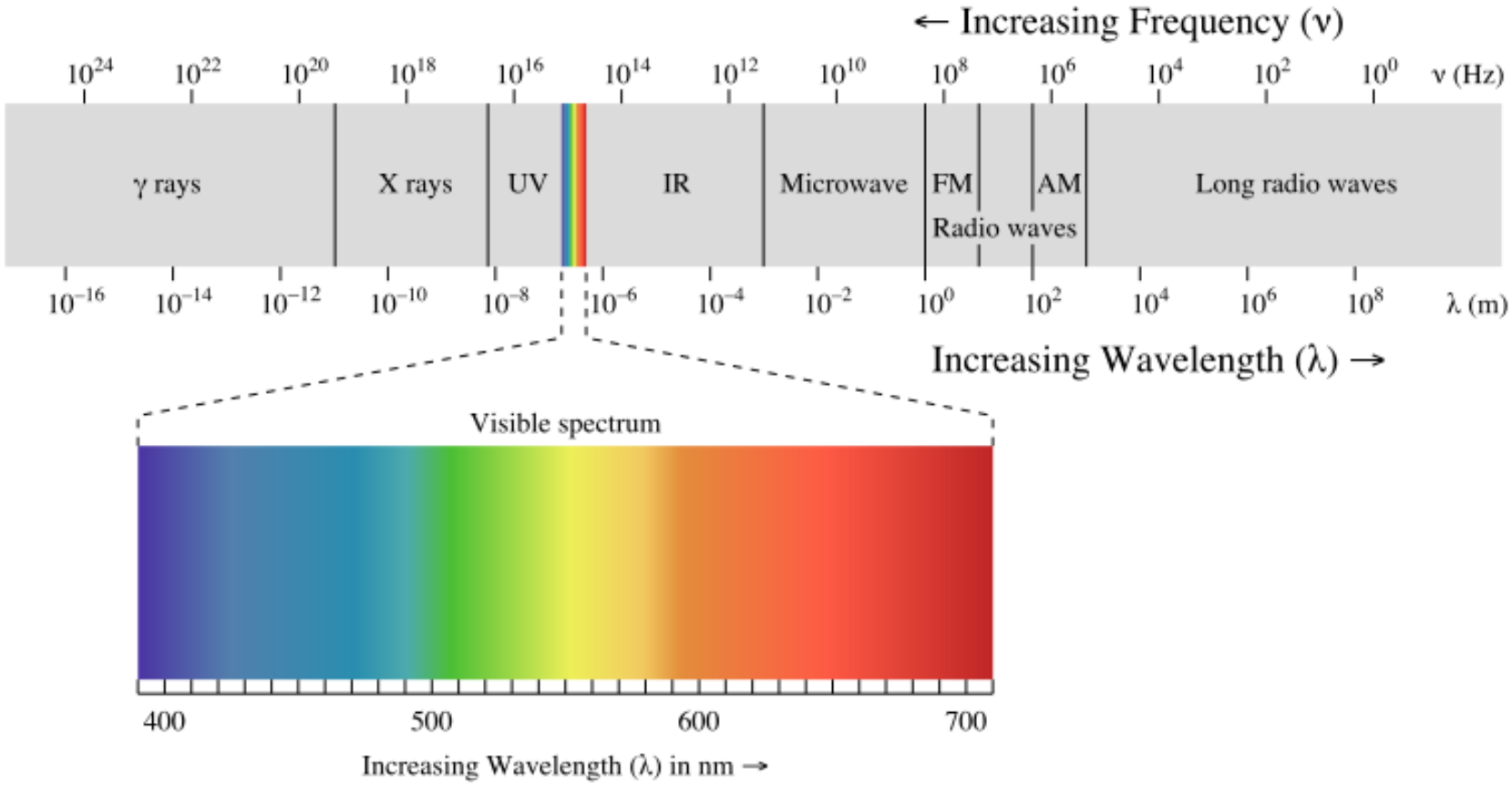
Principle greenhouse gas (GHG): H_2O vapor

Other but less substantial GHGs: CO_2, O_3, O_2, CH_4, N_2O

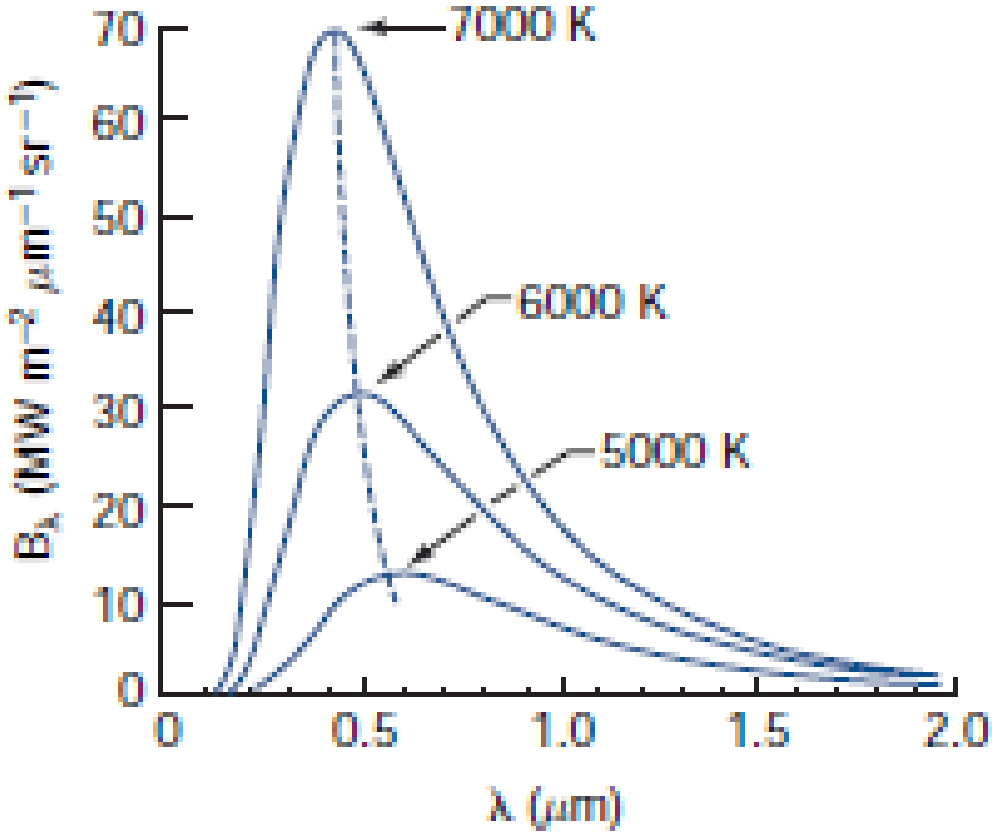
Radiative transfer



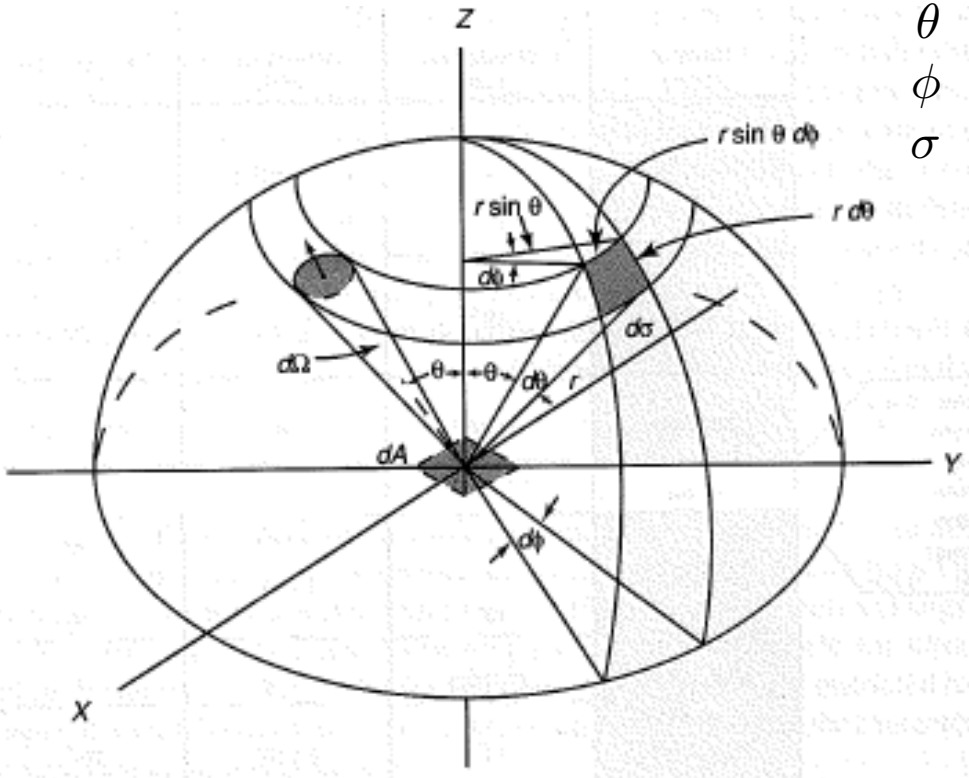
Radiative transfer



Radiative transfer



Radiative transfer



Ω : Solid angle

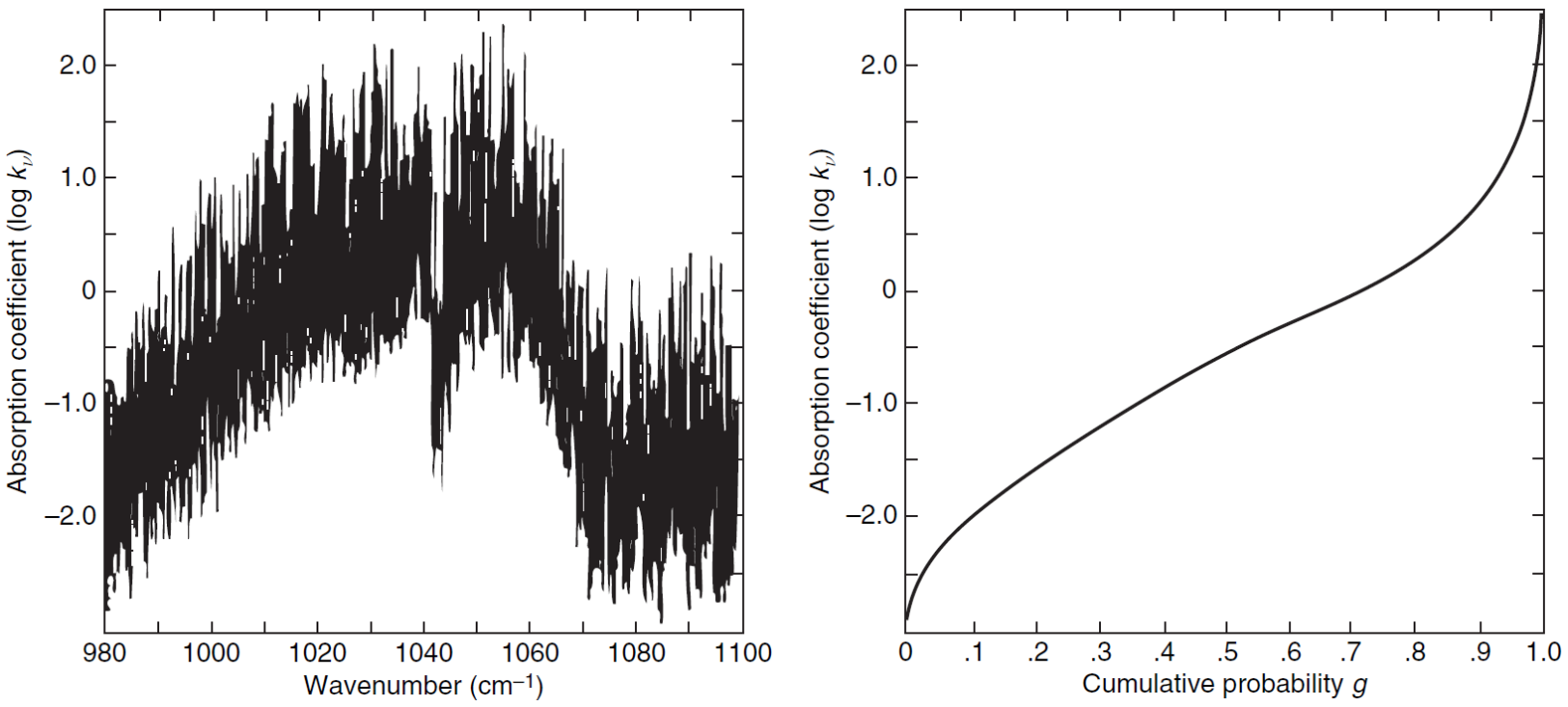
θ : Zenith angle

ϕ : Azimuth angle

σ : Area of a spherical surface

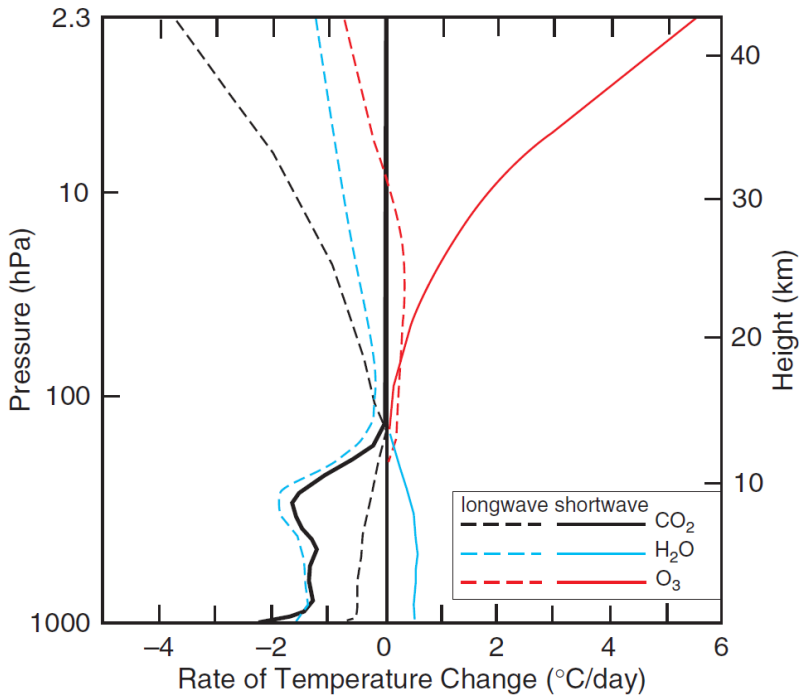
Radiative transfer

Illustration of using the k-distribution method for computing radiative heating rates



Radiative transfer

Vertical profile of longwave and shortwave radiative heating rates



[Adapted from S. Manabe and R. F. Strickler, *J. Atmos. Sci.*, **21**, p. 373 (1964).]

- Longwave cooling throughout troposphere, dominated by H_2O.
- Solar heating in troposphere dominated by absoprtion of H_2O.
- Strong radiative heating in stratosphere associated with O_3.

Radiative transfer

Illustration showing the angular distribution of scattering of radiation in visible bands.

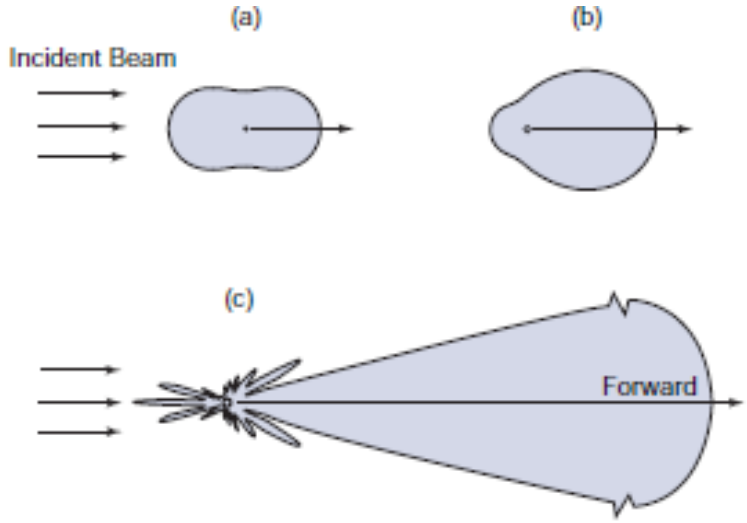


Fig. 4.12 Schematic showing the angular distribution of the radiation at visible (0.5 μm) wavelength scattered by spherical particles with radii of (a) 10^{-4} μm, (b) 0.1 μm, and (c) 1 μm. The forward scattering for the 1-μm aerosol is extremely large and is scaled for presentation purposes. [Adapted from K. N. Liou, *An Introduction to Atmospheric Radiation*, Academic Press, p. 7, Copyright (2002), with permission from Elsevier.]