

Lecture-4

Physical Principles of Remote Sensing: Electromagnetic Radiation

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Radiation Principles

Radiation terminology

(i). Radiant Flux

- Radiant energy/sec(Watts)

(ii). Irradiance or Spectral radiance

- Amount of radiant energy incident on horizontal surface of unit area per unit time

Radiant Energy From Sun

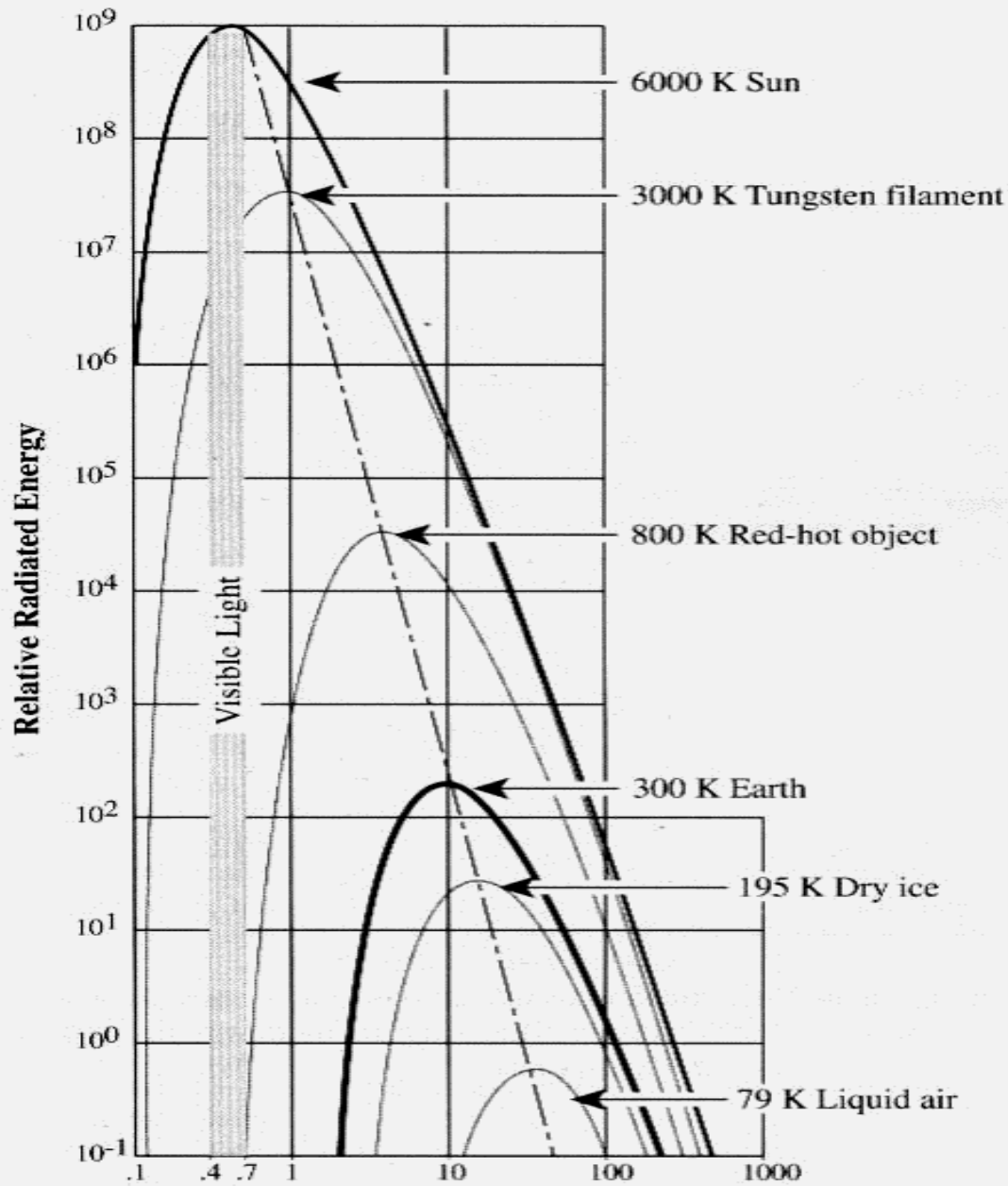
- Radiant energy as per as **Stefan–Boltzmann Law**
- states that the total energy radiated per unit surface area of a black body per unit time (also known as the black-body irradiance or **emissive power**)

$$R_s = E_s \sigma T^4$$

- R_s = Solar Radiation
- E_s = Emissivity of radiating surface
- σ = Stefan–Boltzmann's constant ($5.7 \times 10^{-8} \text{W m}^{-2} \text{K}^{-4}$)
- T = absolute temperature of radiation over surface

Blackbody Radiation

- All objects whose temperature are above absolute zero Kelvin (-273.15°C) emit radiation at all wavelengths
- A “blackbody” is one that is a perfect absorber and perfect emitter (hypothetical, though Earth and Sun are close)
- Intensity and spectral composition of emitted radiation depends upon
 - Matter of the object
 - Its temperature



What do they mean?

- Planck equation gives the radiance of an object at a given temperature at any wavelength
- Stefan-Boltzmann equation describes the total amount of energy being radiated
- Wien's equation describes the wavelength of maximum radiation

Planck Equation..... continued

- Planck's equation describes how heat energy is transformed into radiant energy
- According to Planck's law, an object will emit radiation in all wavelengths but not equally
- This is the basic law for radiation measurements in all parts of the EM spectrum

Examples using Wien's Displacement Equation

$$T_{\text{sun}} = 5800\text{K}$$

$$\text{Peak of Sun's radiation} = \lambda_{\text{max}} (\mu\text{m}) = \frac{2898}{T}$$

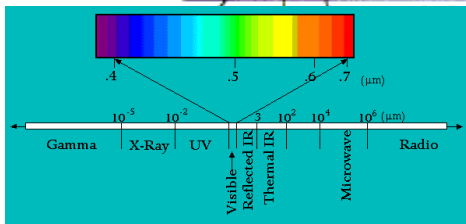
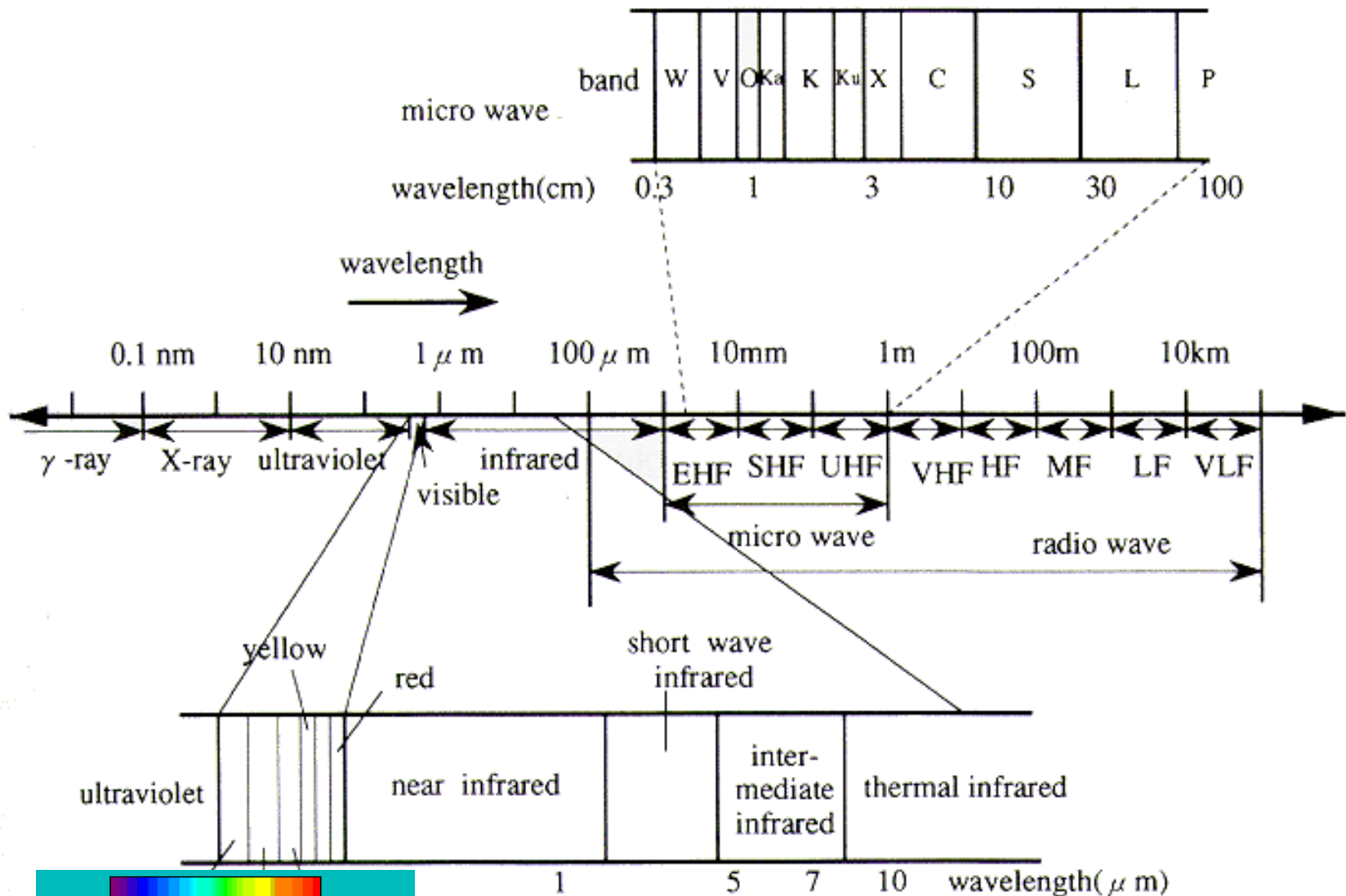
$$2898\text{mmK} / 5800\text{K} = 0.5 \text{ mm}$$

$$T_{\text{earth}} = 288\text{K}$$

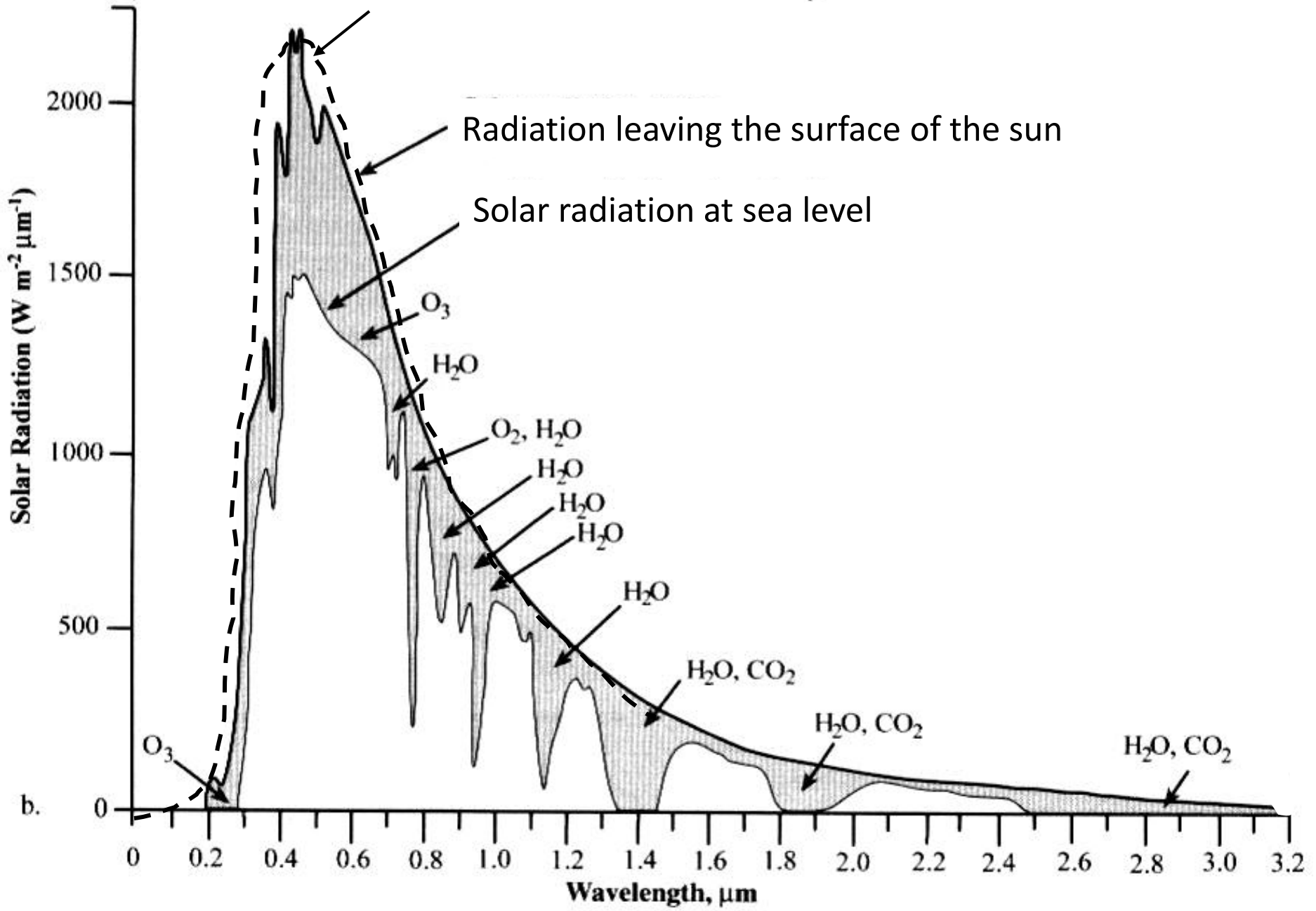
$$\text{Peak of Earth's radiation} = 2898\text{mmK} / 288\text{K} = 10 \text{ mm}$$

Sun's Radiant Energy Distribution

Name of Spectral Region	Wavelength Range, μm	Percent of Total Energy
Gamma and X-rays	< 0.01	Negligible
Far Ultraviolet	0.01 - 0.2	0.02
Middle Ultraviolet	0.2 - 0.3	1.95
Near Ultraviolet	0.3 - 0.4	5.32
Visible	0.4 - 0.7	43.5
Near Infrared	0.7 - 1.5	36.8
Middle Infrared	1.5 - 5.6	12.0
Thermal Infrared	5.6 - 1000	0.41
Microwave	> 1000	Negligible
Radio Waves	> 1000	Negligible



The bands used in remote sensing



b.

- For terrestrial remote sensing, the most important source is the sun
 - Reflected solar energy is used 0.3 - 2.5 μm
- The Earth is also an energy source
 - >6 μm for self-emitted energy

