
name

1. At the equator the solar irradiance reaching the surface is $\sim 1000 \text{ W m}^{-2}$ at high noon on the day of the equinox (when the latitude is equal to the zenith angle). Neglecting the change in atmospheric absorption with latitude, what are the values of the solar heat flux at 30° , 45° , and 60° latitude?
2. The Earth's global mean temperature is $15^\circ\text{C} = 288\text{K}$. In midsummer, the sea surface temperature is typically 30°C . In the Yukon wintertime temperatures can be -40°F , which coincidentally is also -40°C . What are the wavelength of maximum emission (μm) and total blackbody radiation emitted (Wm^{-2}) at all three temperatures? In what band of the electromagnetic spectrum to all of these emissions lie?
3. The Klingon home world, Qo'onoS, orbits star Omega Leonis, which has a surface temperature of 5600K . In what band of the electromagnetic spectrum does it emit peak energy?
4. Recall the expression that we derived in class for the Earth's blackbody temperature, $S_0(1-\alpha) = 4\sigma T^4$, where $S_0 = 1366 \text{ Wm}^{-2}$ is the solar constant, $\alpha = 0.30$ is that Earth's albedo, and the other symbols have the same meanings as above. Given that the Earth's present blackbody equilibrium temperature is 256K , what would it be if the solar constant increased by 10%. (Hint to simplify the calculation take the ratio of the above equation before and after the increase.)

Useful Formulas:

Cosine Law for computing incoming radiation at the surface:

$$I(\varphi) = I_0 \cos \varphi,$$

where $I(\varphi)$ is the high-noon solar irradiance at latitude (or at zenith angle) φ and I_0 is the irradiance at the Equator, or when $\varphi = 0$. As written here it does not include atmospheric absorption.

Wien's Displacement Law for computing the wavelength of maximum electromagnetic radiation emission:

$$\lambda_{\max} = 2897 / T,$$

where λ_{\max} is in micrometers ($\mu\text{m} = 10^{-6} \text{ m}$) and T is in Kelvins ($\text{K} = ^\circ\text{C} + 273.16$)

Stefan-Boltzmann Law for computing total blackbody radiation emitted:

$$E = \sigma T^4,$$

Where E is in $\text{W m}^{-2} = \text{J s}^{-1}\text{m}^{-2}$, T is in K, as above, and $\sigma = 5.67 \times 10^{-8} \text{ Wm}^{-2}\text{K}^{-4}$.

Electromagnetic Spectrum

