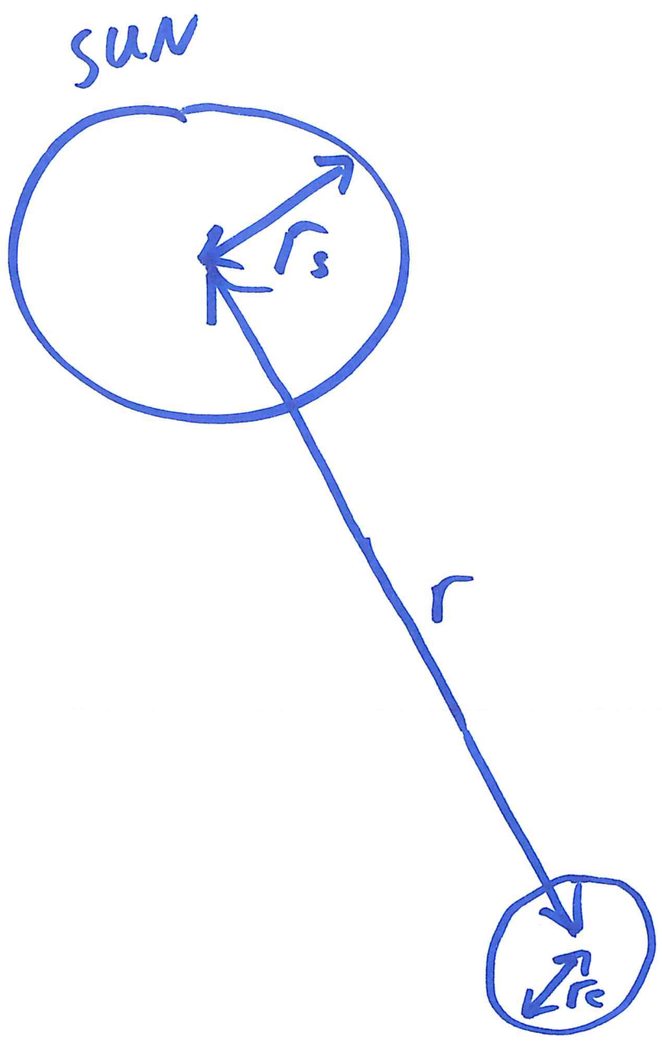
The Temperature of the Earth



$r_s = 6.955 \times 10^8 m$

$r_e = 6.35 \times 10^6 m$

$r = 1.50 \times 10^{11} m$

$T_e = 5800 K$

① Power Output of sun:

$$P = A_\sigma T^4 = 4\pi r_s^2 \times T_s^4 \times \sigma$$
$$= 3.9 \times 10^{26} W$$

② Intensity of Sunlight arriving at Earth:

$$I = \frac{3.9 \times 10^{26}}{4\pi r^2} = 1379 W m^{-2}$$

③ Area of absorbtion by Earth:

$$A_{absorbed} = \pi r_e^2 = 1.27 \times 10^{14} m^2$$

④ Power absorbed by Earth:

$$P_{absorbed} = I \times A_{absorbed} = 1.75 \times 10^{17} W$$

(5) Area of emission by Earth:

$$A_{emitting} = 4\pi r_c^2 = 5.07 \times 10^{14}\ m^2$$

(6) Power emitted by Earth in terms of its temperature, T_E:

$$P_{Emitted} = A_{emitting}\ \sigma\ T_E^4$$

(7) Using thermal equilibrium:

$$P_{emitted} = P_{absorbed}$$

$$1.75 \times 10^{17} = A_{emitting}\ \sigma\ T_E^4$$

$$T_E = \sqrt[4]{\frac{1.75 \times 10^{17}}{\sigma \times 5.07 \times 10^{14}}} = 279\,K$$

Temperature of the Earth:

$$\underline{279\,K \quad (6^\circ C)}$$

Comment:

< true temperature (15°C) due to atmosphere, not true black body