SOLAR IRRADIANCE

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The luminosity of the Sun is

$$L_S = 3.839 \times 10^{26} \text{ watts} \tag{1}$$

On a sphere of radius r centred at the Sun, the power received is therefore

$$F = \frac{L_S}{4\pi r^2} \tag{2}$$

which is the inverse square law for radiation from a spherically symmetric source. At the distance of the Earth, $r = 1$ AU $= 1.496 \times 10^{11}$ m so the solar flux, known as the *solar irradiance*, is

$$F_S = 1365 \text{ W m}^{-2} \tag{3}$$

This is the power received when the Sun is directly overhead, which can occur only between the tropics of Cancer and Capricorn. At my latitude of around 56° N, the highest the Sun can get in the sky occurs at noon on the summer solstice, when the Sun's declination is around $+23°$, putting it at an altitude of $(90-56+23) = 57°$. The flux here is therefore

$$F_{summer} = F_S \sin 57° = 1145 \text{ W m}^{-2} \tag{4}$$

At the winter solstice, the Sun's maximum altitude is $90-56-23 = 11°$, giving a flux of

$$F_{winter} = F_S \sin 11° = 260 \text{ W m}^{-2} \tag{5}$$

I've actually measured this in my own backyard with my weather station (see the High Solar Rad graph about halfway down the page) and the numbers do check out; in June the highest recorded radiation is between 1100 and 1200 and in December it peaks at around 200.

A somewhat dated comparison is to look at the radiation emitted by an old-fashioned 100 W light bulb. In order for us to receive the solar irradiance from such a bulb, we'd need to be at a distance

$$r=\sqrt{\frac{100}{4\pi\times1365}}=7.6\text{ cm} \tag{6}$$

More modern light bulbs such as LEDs emit just as much light as the old high-power bulbs but consume much less power (a typical LED consumes under 5 watts). This is because most of the energy in an LED goes into emitting light while in an old 100W bulb, a large portion of the energy is radiated as heat (or to be more precise, infrared radiation).

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