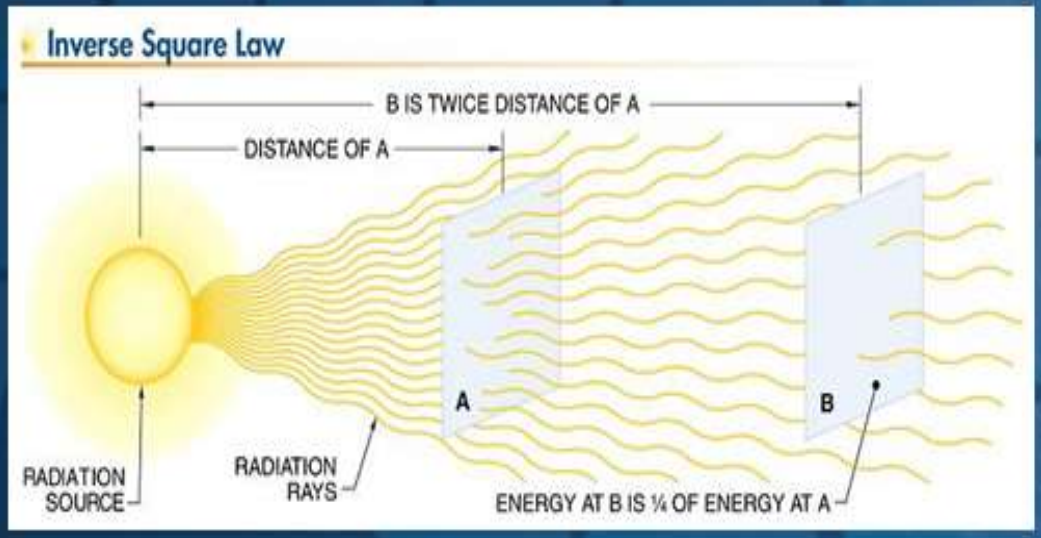
SOLAR ENERGY AND RADIATION

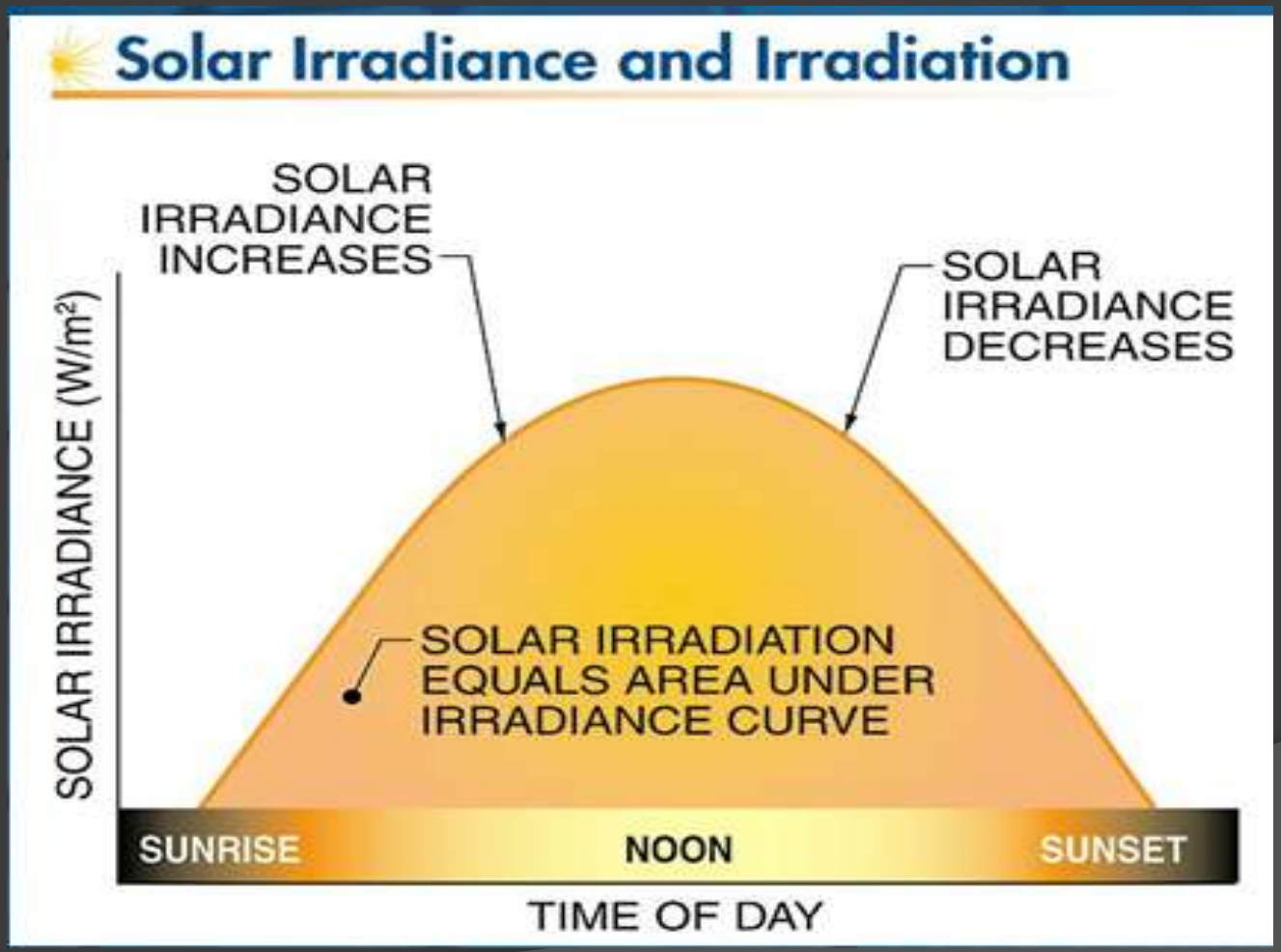
Angel Susan Cherian

Solar Radiation

The inverse square law states that radiation energy is reduced in proportion to the inverse square of the distance from the source.



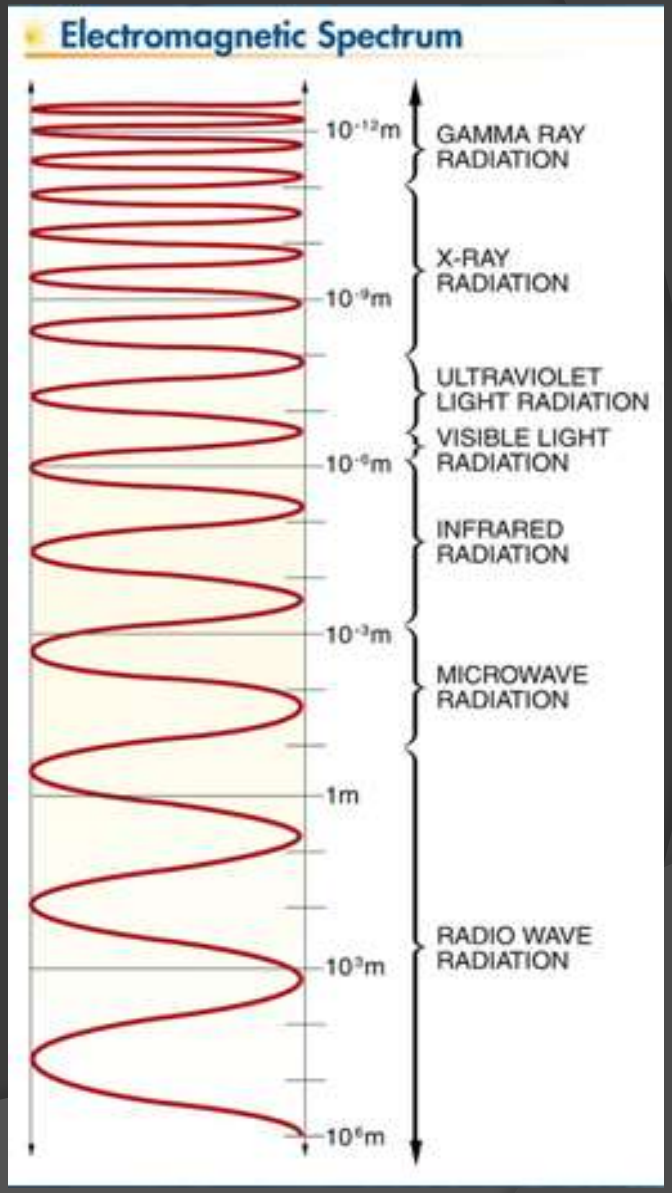
Solar Radiation



Solar Radiation

- **Solar Spectrum** most the energy received from the sun is electromagnetic radiation in the form of waves.

- **Electromagnetic Spectrum** is the range of all types of electromagnetic radiation, based on wavelength.



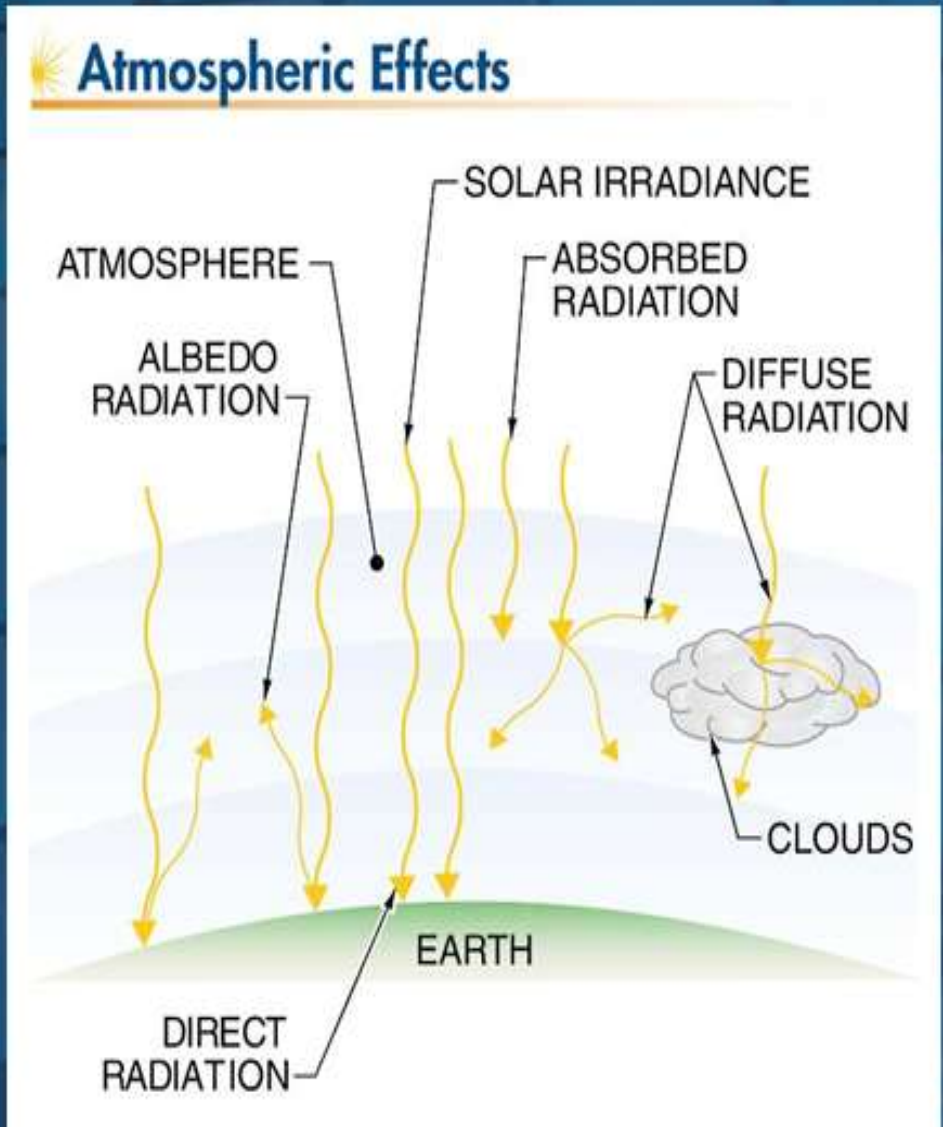
Solar Radiation

- **Atmospheric Effects:** Solar radiation is absorbed, scattered and reflected by components of the atmosphere
- The amount of radiation reaching the earth is less than what entered the top of the atmosphere. We classify it in two categories:

1. **Direct Radiation:** radiation from the sun that reaches the earth without scattering
2. **Diffuse Radiation:** radiation that is scattered by the atmosphere and clouds

Solar Radiation

- Solar radiation entering Earth's atmosphere becomes direct, diffuse, or albedo radiation.



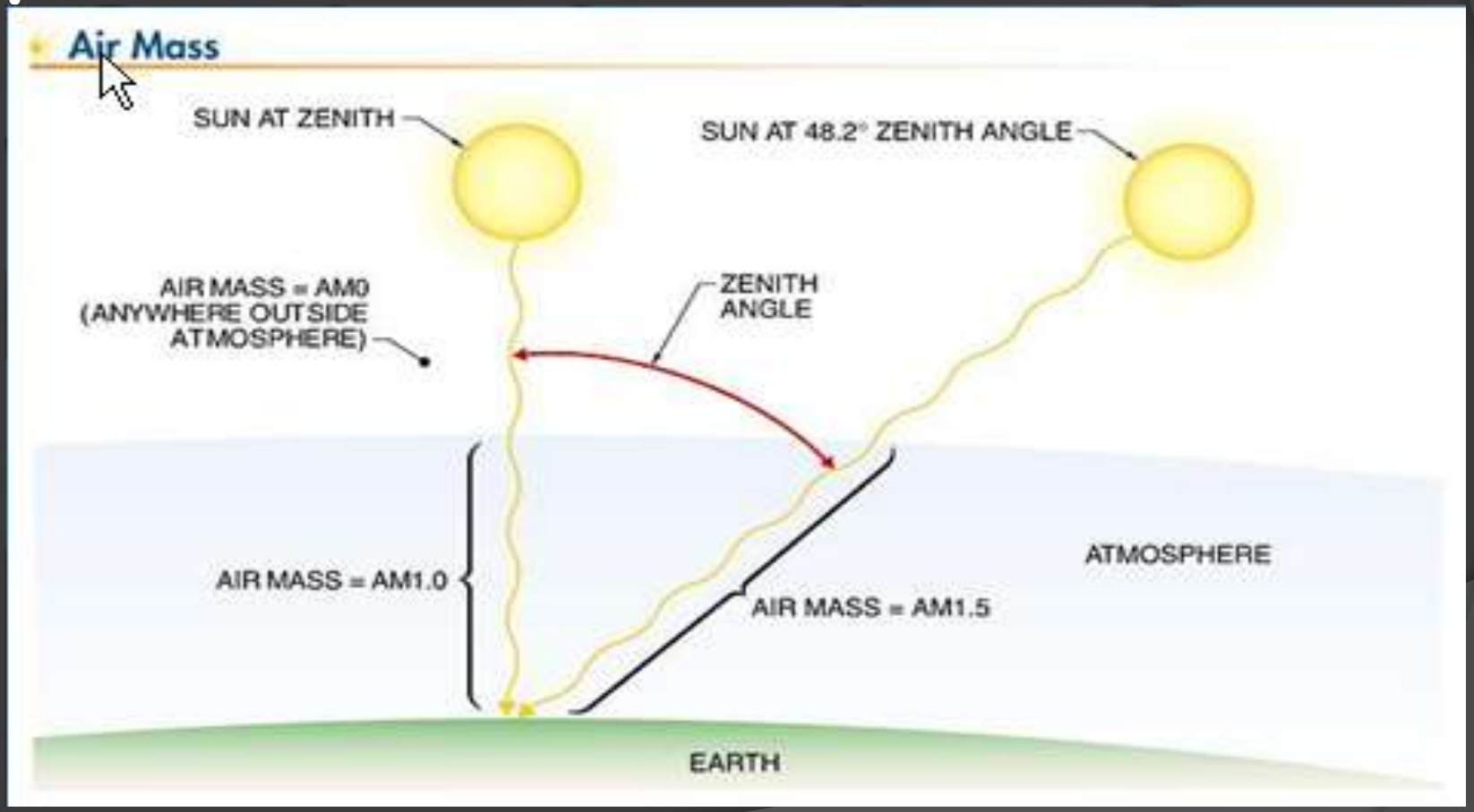
Solar Radiation

- **Air Mass** represents how much atmosphere the solar radiation has to pass through before reaching the Earth's surface
- Air Mass (AM) equals 1.0 when the sun is directly overhead at sea level. $AM = 1/\cos \Theta z$
- We are specifically concerned with terrestrial solar radiation – that is, the solar radiation reaching the surface of the earth.

Solar Radiation

- **Zenith** is the point in the sky directly overhead a particular location –as the Zenith angle **Θz** increases, the sun approaches the horizon.

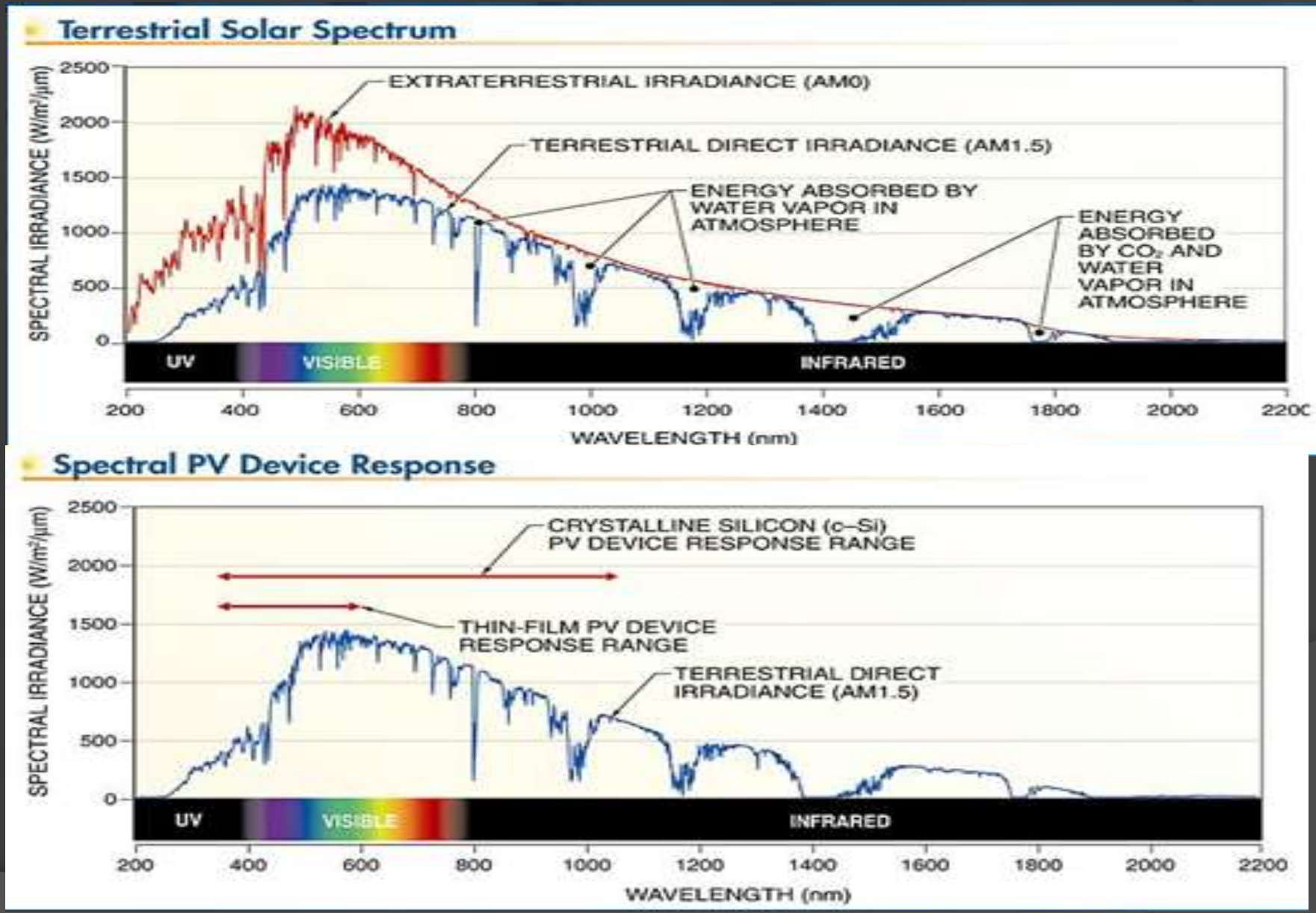
AM = 1/ Cos Θz



Solar Radiation

- **Solar spectral distribution** is important to understanding how the PV modules that we're going to utilize respond to it
- **Most Silicon based PV devices** respond only to visible and the near infrared portions of the spectrum
- **Thin film modules** generally have a narrower response range

Solar Radiation



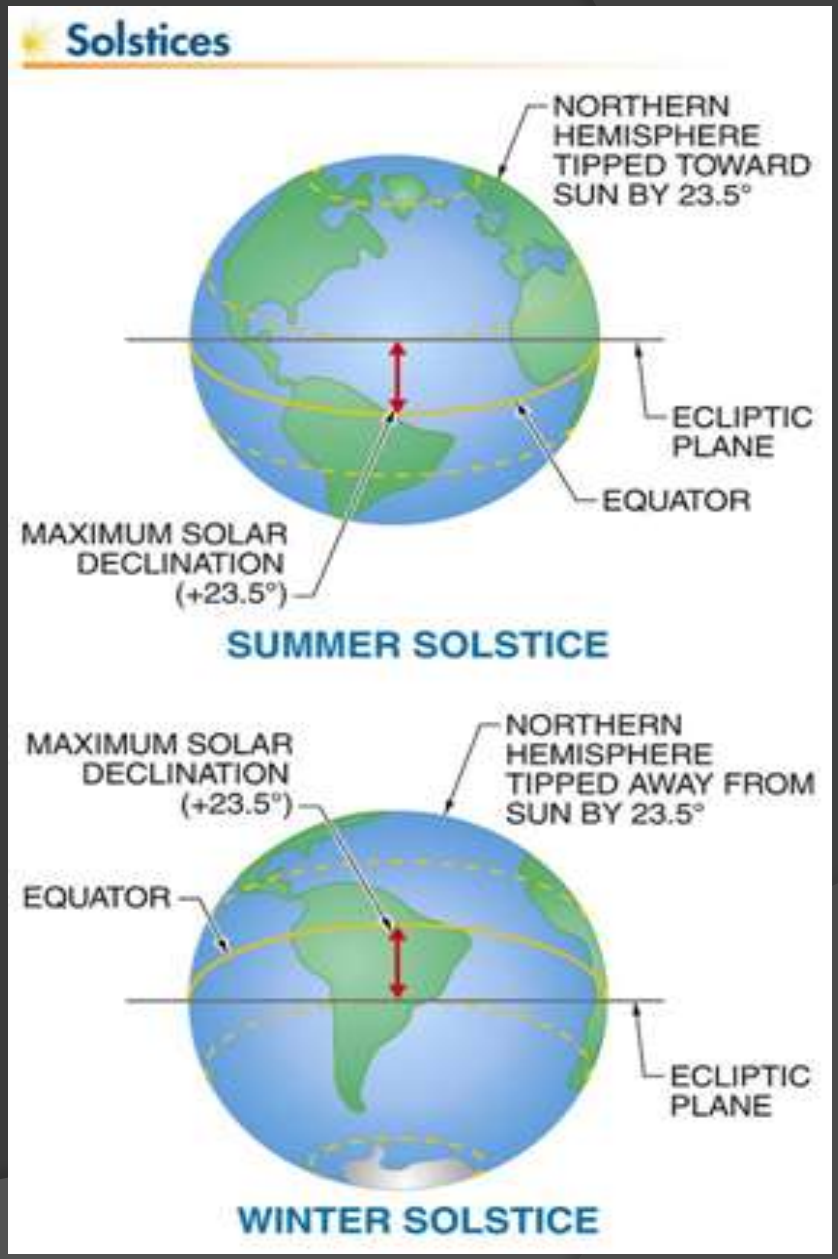
Solar Radiation

- Long-term solar irradiation measurements are the basis for developing databases, which help us to calculate output.
- Being able to predict the output of our PV system, and this will allow us to know whether it is working adequately or not
- Predicting output will help us to calculate the cost of the energy generated over a given time period
- **Pyranometers** measure irradiance.
- **Pyrheliometers** measure direct solar radiation (and ignore diffuse) and I've never ran into a situation where I had to use one

Solar Radiation

Summer Solstice is at maximum solar declination (+23.5º) and occurs around June 21st –Sun is at Zenith at solar noon at locations 23.5º N latitude

Winter Solstice is at minimum solar declination (-23.5º) and occurs around December 21st



Solar Radiation

Equinoxes occur when the solar declination is zero. Spring equinox is around March 21st and the fall equinox occurs around September 21st –Sun is at Zenith at solar noon on the equator.