#flo #ret #ref #disorganized #incomplete #hw

1 | Les go.

- we need to figure out:
  - what is the curve of generation over a day
  - how does this curve shift over the seasons?
- our inputs
  - location
  - time of year (season)
- output
  - generation curve over a day

look into: Global Tilted Irradience.

all we care about is the relative shape and how the relative shape changes! this is because the other stuff will be consistent, and we aren't recommending a solar system

1.0.1 | terms:

solar irradiance: power per unit area (W/m^2) integrated over time gives us: insolation (j/m^2) solar irradiance aka solar flux: power per unit area!

TSI: total solar irradiance. when the sun is perpendicular! over a sqaure meter. this is just a constant

zenith angle: angle between suns rays and vertical direction (of earth). "local normal to earths surface" and sun rays (line between point on earth surface and sun)

declination angle: lattitude of point directly under the sun at **noon** complement of solar zenith angle

subsolar point: point that is closest to the sun on a planet

hour angle h: defined as the longitude of the subsolar point relative to its position at noon. AKA how far it moves in an hour!

A cos zenith angle is the area of sunlight recieved per area on earth AKA how much sunlight area ur actully getting for an area on earth.

1.0.2 | helpful relations

spherical law of cosines!

Q¯day=S0πd¯d2[h0 sinϕ sin δ+cosϕ cos δ sin h0]

1.0.3 | **Vars!**

Assume circular orbit?

charge $Q = S_0 \left(\frac{\overline{R_0}}{R_e}\right)^2 \cos\theta_s$ or $Q = \begin{cases} S_o \frac{R_o^2}{R_E^2} \cos(\Theta) & \cos(\Theta) > 0 \\ 0 & \cos(\Theta) \leq 0 \end{cases}$ can be aproximated as $Q \approx S_0 \cos\theta_s$

declination angle $\delta = -0.409 \cdot \cos\left(\frac{2\pi}{365} \cdot (d+10)\right)$

spherical law of cosines $\cos(c) = \cos(a)\cos(b) + \sin(a)\sin(b)\cos(C)$ and derivation $C = h$ $c = \Theta$ $a = \frac{1}{2}\pi - \phi$ $b = \frac{1}{2}\pi - \delta$

to calculation of cos(zenith) $\cos(\Theta) = \sin(\phi)\sin(\delta) + \cos(\phi)\cos(\delta)\cos(h)$

substituting back in $Q = S_0 \left(\frac{\overline{R_0}}{R_e}\right)^2 (\sin(\phi)\sin(\delta) + \cos(\phi)\cos(\delta)\cos(h))$

we can get the delta with $\delta = -0.409 \cdot \cos\left(\frac{2\pi}{365} \cdot (d+10)\right)$ where 23.45deg in radians in 0.409

integrating over a day, h goes from pi to negative pi $\overline{Q}^{\text{day}} = -\frac{1}{2\pi}\int_{\pi}^{-\pi} Q\, dh$

$\frac{R_o^2}{R_E^2}$ is constant, so the integral becomes

$$\begin{aligned} \int_{\pi}^{-\pi} Q\, dh &= \int_{h_o}^{-h_o} Q\, dh \\ &= S_o \frac{R_o^2}{R_E^2} \int_{h_o}^{-h_o} \cos(\Theta)\, dh \\ &= S_o \frac{R_o^2}{R_E^2} \left[h \sin(\phi)\sin(\delta) + \cos(\phi)\cos(\delta)\sin(h)\right]_{h=h_o}^{h=-h_o} \\ &= -2 S_o \frac{R_o^2}{R_E^2} \left[h_o \sin(\phi)\sin(\delta) + \cos(\phi)\cos(\delta)\sin(h_o)\right] \end{aligned}$$

factoring in the -1/2pi,

we get the:

final

$$\overline{Q}^{\text{day}} = \frac{S_0}{\pi} \frac{R_0^2}{R_e^2} \left[h_0 \sin(\phi)\sin(\delta) + \cos(\phi)\cos(\delta)\sin(h_0)\right]$$

wiki: Let $\_h_0$ be the hour angle when Q becomes positive. This could occur at sunrise when $\Theta = \frac{1}{2}\pi$, or for $\_h_0$ as a solution of

$\sin(\phi)\sin(\delta) + \cos(\phi)\cos(\delta)\cos(h_o) = 0$

or

$\cos(h_o) = -\tan(\phi)\tan(\delta)$ end wiki therefore, $h_0 = \cos^{-1}(-\tan(\phi)\tan(\delta))$

theoretical daily average insolation at the top of the atmosphere as a function of lattitude and time of year Pasted image 20211110162119.png

Pasted image 20211110172859.png equator, summer solstice