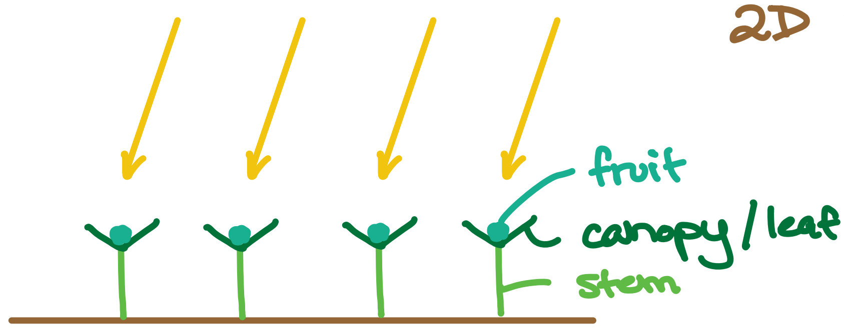
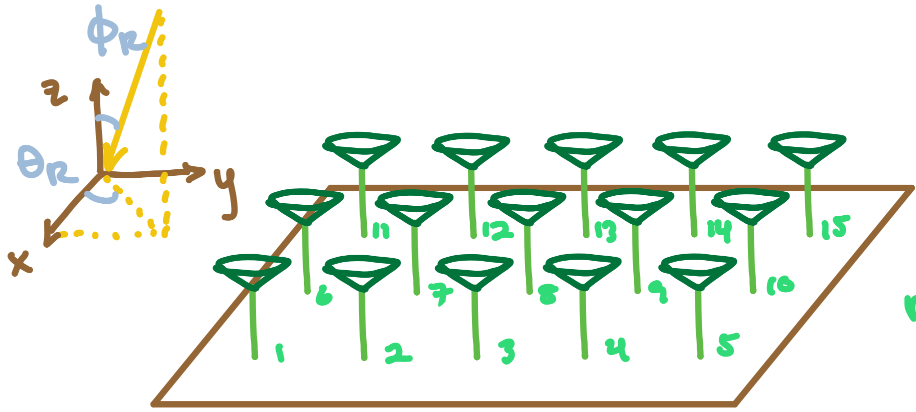
Solar Model

2D view



3D view



$m = 1, \ldots, 15$

To Define All the Test Points

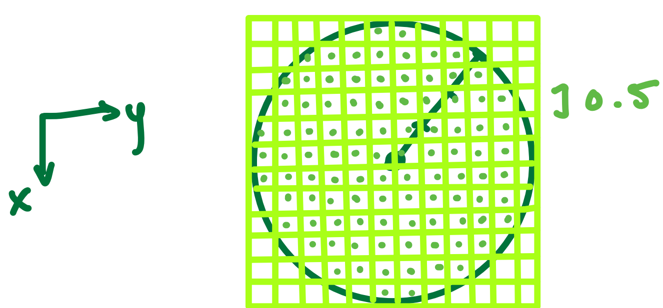
Given center coordinates and radius (e.g. 3) along with

$$\rho_{comp} = 1 \text{ test points / unit area}$$

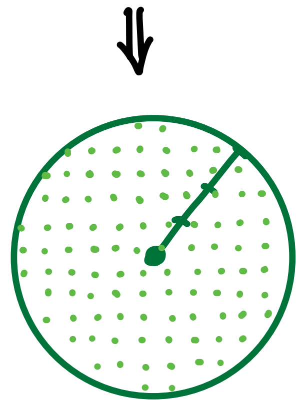
$$A_{comp} = \text{unit area} \quad \text{e.g. } 0.5 \times 0.5$$

We can define the (x, y) coordinates of the test points according to

$r = 3$



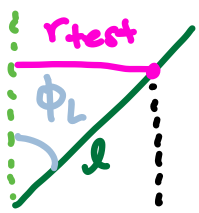
one test point per center



To find the z-coordinates of the test points, we find the distance from the point to the center:

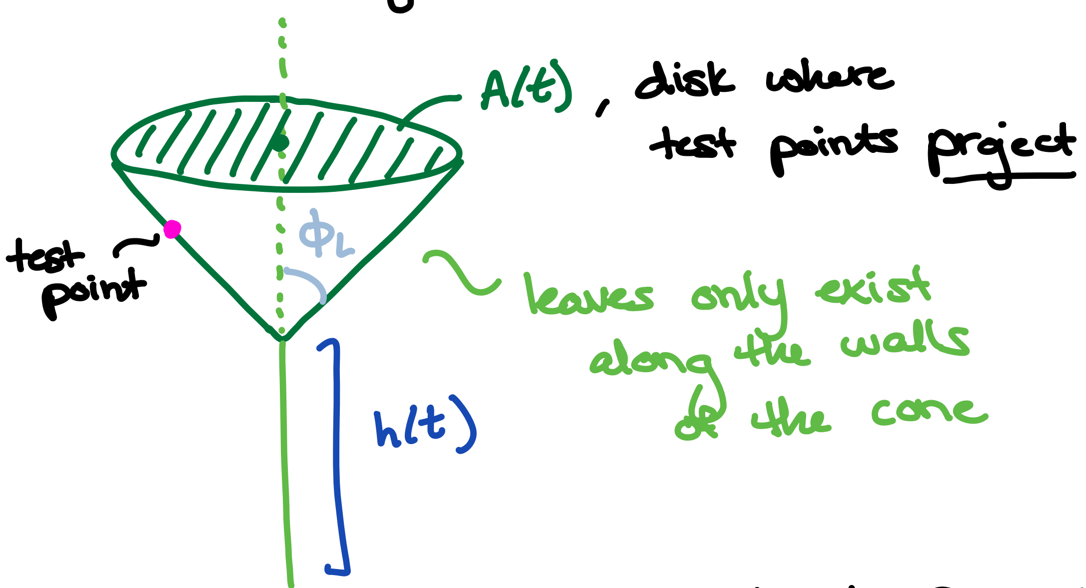
$$r_{test} = \sqrt{x_{test}^2 + y_{test}^2}$$

Then use the leaf angle to get the z-coordinate:



$$r_{test} = l \sin \phi_L$$
$$z_{test} = l \cos \phi_L \implies z_{test} = r_{test} \cot \phi_L$$

For light incident on a single test point in plant i,



We need to find the angle between the leaf and incident light in order to find the extinction coeff.

To do this, we use the formula

$$\kappa = \sin \phi$$

where

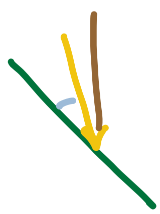
$$\phi = \phi_L - \phi_R \cos(\theta_L - \theta_R)$$

But why?

Well, light only hits test points when $\theta_R < \theta_L$

and, consider the two edge cases

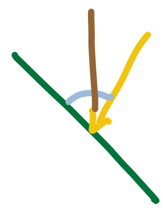
Case 1: $\theta_L - \theta_R = 0$



$\Downarrow$

Use $\phi_L - \phi_R$

Case 2: $\theta_L - \theta_R = \pi$

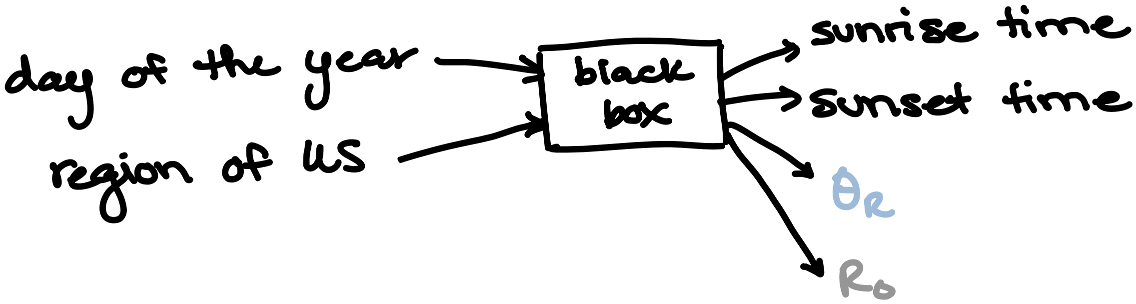


$\Downarrow$

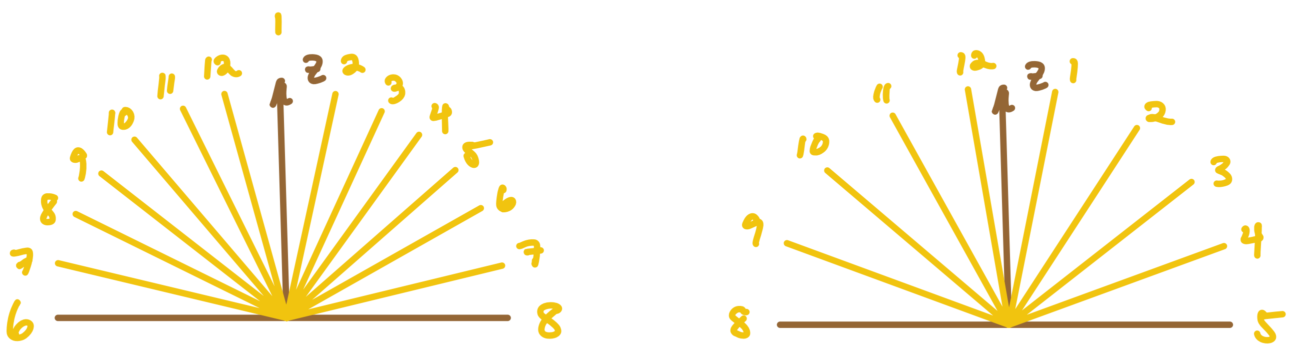
Use $\phi_L + \phi_R$

$$\phi_L - \phi_R \cos(\theta_L - \theta_R)$$

Use real-world data on trajectories of sun over the Earth at different times of the year to obtain:



Using this information, our job is to obtain hourly values of ϕ_R.



Summer | Winter

Sunrise = 6
Sunset = 8 (20)

$$\Rightarrow \phi_R = \frac{\pi t}{\text{sunset} - \text{sunrise}}$$

where t is the current time of the day on the 24 hour clock.