We’ve Done this....
Now! Let’s do this!

- Let’s also look at the earth’s energy budget from space.
- Energy in = Energy Out once equilibrium is reached

Energy is absorbed on a “flat disk” facing the sun

Energy is emitted over a sphere in all directions
Energy Budget w/o an Atm...

- A very simple radiation budget!

\[ \Delta Q = \Delta U + \Delta W \]

\[ M = \varepsilon \sigma T^4 \]

\[ S_{abs} = (1 - A) S_o \]
energy budget w/o an atm...

we can then create a rate of change formula that we can then use to solve for $T(t)$ or $U(t)$

$$\frac{dU}{dt} = \frac{dQ}{dt}$$

$$mc \frac{dT}{dt} = \left( \frac{dQ}{dt} \right)_{in} - \left( \frac{dQ}{dt} \right)_{out}$$

$$\frac{dT}{dt} = \frac{1}{mc} \left[ \left( \frac{dQ}{dt} \right)_{in} - \left( \frac{dQ}{dt} \right)_{out} \right]$$

$$\frac{dT}{dt} (t) = \frac{A_d (1 - A) S_o}{mc} - \frac{A_s \varepsilon \sigma T^4}{mc}$$

$$\frac{dT}{dt} (t) = C_{in} - C_{out} T^4$$
Energy Budget w/o an Atm...

Here’s how we do it in Meteorology Classes

\[ \ln = Out \]

\[(mc)_e (\pi r_e^2)(1 - A)S_o = (mc)_e (4\pi r_e^2)(\varepsilon\sigma T^4)\]

Notice how this solution is Independent of (mc) and earth’s radius!

\[ T = \left( \frac{(1 - A)S_o}{4\varepsilon\sigma} \right)^{1/4} \]

(earth’s distance to the sun is implicit in the solar constant)

\[ T \approx 255K \]
Let’s spend 45 minutes doing this.

- Create this system in Stella

\[ \ln = \text{Out} \]

\[ (mc)_e (\pi r_e^2)(1 - A)S_o = (mc)_e (4\pi r_e^2)(\varepsilon\sigma T^4) \]
But this IS an ATM class....
(Let’s see what we can do in the 2^{nd} half of class!)

\[ T_{\text{ATM}}, \varepsilon_a, mc_{\text{ATM}} \]

\[ \frac{1}{4} S_o (1-0.25) \]