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CIV300 Assignment #1

1. **The "evapotranspiration" (ET) represents the combined effect of evaporation from open water sources and the movement of water through plants (transpiration). It is difficult to measure but its closely dependent term, precipitation, is much easier to measure, though global and temporal averages are still not trivial. What is the global average daily depth of precipitation that is consistent with the 78 W/m2 indicated here?**

78 W/m^2 is the energy available to cause the phase change from water to vapor. If we take 2.5 MJ/kg as the latent heat of water, and 6,371 x 10^3 m as the radius of the earth, then we can calculate the average daily *h* of precipitation:

Latent heat of vaporization: Q = mL

where,

Q = heat being absorbed

L (Latent heat of vaporization) = 2.5 MJ/kg

m = mass of water

78 W/m2 = energy available for phase change

A = 4 πR2 = surface area of the earth

R = 6,371 x 103 m

Solving for m,

- $Q = 78\frac{J}{m^2 s} \times \frac{86400\,s}{day} \times\ 4\pi(6{,}371 \times 10^3 \mathrm{m})^2\ = 3.437\ \times\ 10^{21}\frac{J}{day}$

Then using the latent heat of vaporization,

- $Q = mL$
- $Q = 78\frac{J}{m^2 s} \times \frac{86400\,s}{day} \times\ 4\pi(6{,}371 \times 10^3\ \mathrm{m})^2\ = 3.437\ \times\ 10^{21}\frac{J}{day}$
- $3.437\ \times\ 10^{21}\frac{J}{day} = m\left(2.5 \times 10^6\frac{J}{kg}\right)$
- $m = 1.3749\ \times\ 10^{15}\frac{kg}{day}$

To find the height *h*, we can relate the mass to the height trough the density of water and the area of the Earth's surface,

- $\rho = \frac{m}{V}$
- $V = A \times h = 4\pi R^2 \times h$
- $\rho = 1000\ \frac{kg}{m^3} = \frac{1.3749 \times 10^{15}\frac{kg}{day}}{5.1{\times}10^{14}\,m^2 \times h}$
- $h = \frac{1.3749 \times 10^{15}\frac{kg}{day}}{1000\frac{kg}{m^3} \times 5.1{\times}10^{14}\,m^2}$
- **Finally, $\boldsymbol{h = 0.002696\ m}$ or $\boldsymbol{h = 2.67\ mm}$**