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Lower Tropospheric Solar Irradiance Modeling

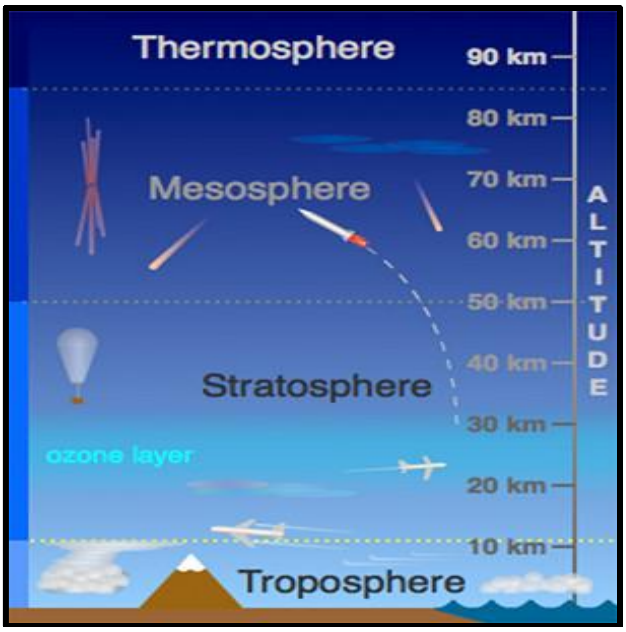
Dr. Rohini V S

Associate Professor, Department of Physics, Nrupatunga University, Bangalore-560001, Karnataka, India
neelarohini[at]gmail.com

Abstract: ***Solar radiation can be used as an effective tool to determine atmospheric composition and thus indoor/lower tropospheric irradiance modelling can be done.***

Keywords: Tropospheric Solar Irradiance

1. Introduction



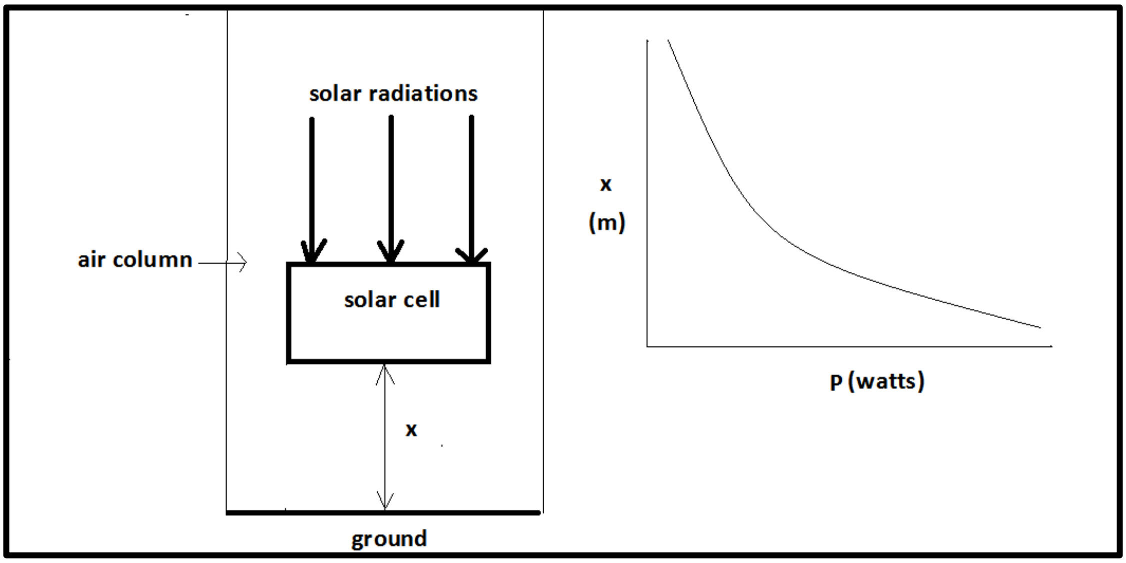
Earth atmosphere is consiting of layers
1) Troposphere 0-10km
2) Stratosphere 10-50km
3) Mesosphere 50-85 km
4) Thermosphere > 85km

Troposphere 0-10km

Most of our day today life activities are concentrated in lower tropospheric region 0-5km altitude with composition N2, O2, CO2, H20 along with the molecules contributed by living organisms, green house gases. The higher level of green house gases increases the ambient temperature such that ozone (**O_3**) production is enhanced. The contribution by living organisms includes nonorganic radicals like **Na, cl, K, Pb, C, Ca, Si** and other toxic radicals. Hence it is worth to study the ambient charecterstic of lower troposhphere. The molecular species prasent in this layer is of most importance in our daily healthy life. Thus interactions of these molecular species with incoming radiation like solar radiation is studied and an effective theoretical modelling for lower tropospheric solar irradiance is obtained.

2. Methodology

Solar radiations falling on a solar cell kept in the ambient atmosphere generates power. This power so generated is recorded at various locations as a function of height less than 5km. This serves as our primary data. Using this data theoretical modelling of solar irradiance for lower troposphere at a particular locality is done.



The power so generated by a solar cell shows exponential behaviour governed by law

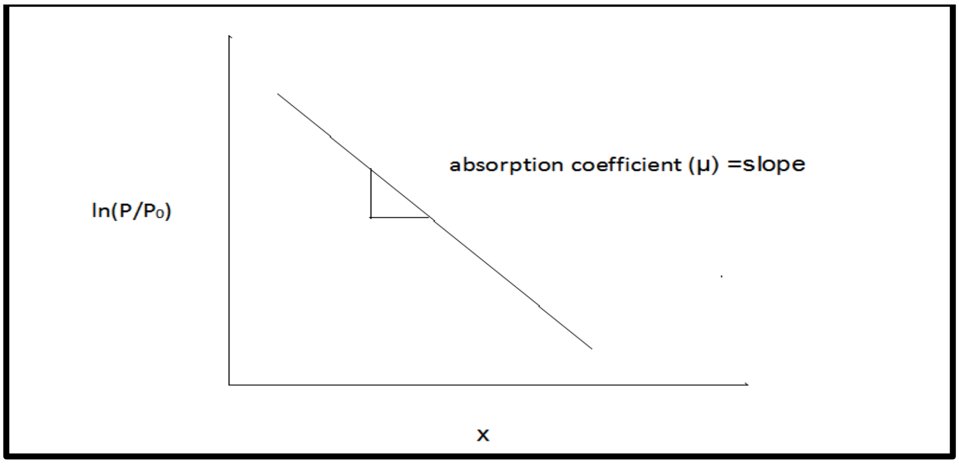
$$P=P_0\, e^{-\mu x} \qquad \ldots\ldots (1)$$

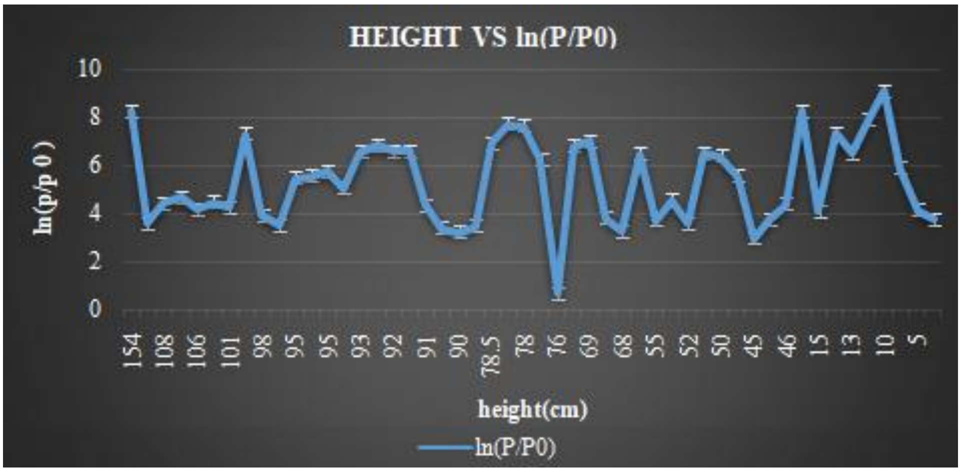
Where
P-power at the point of observation, **P_0**-power above the air column

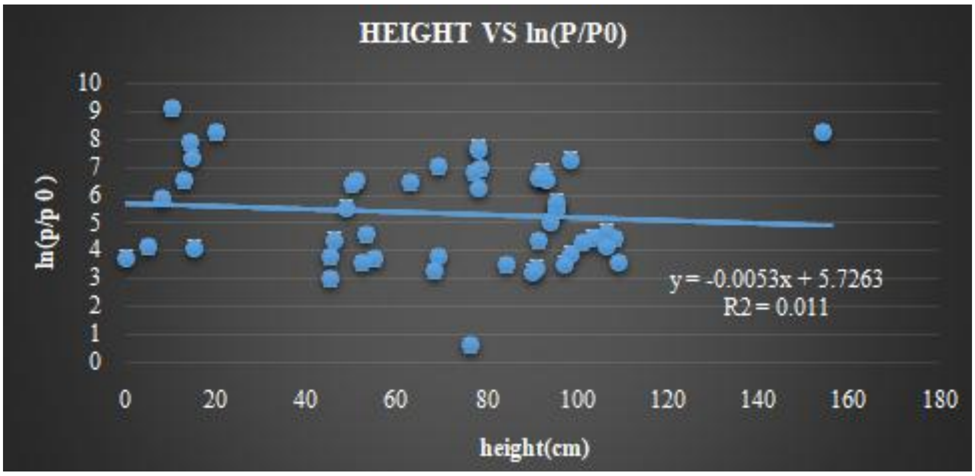
μ-absorption coefficient of air, **x**-height of solar cell from ground/earth

$$\ln (P/P_0) = -\mu x \qquad \ldots\ldots. (2)$$

By plotting ln (P/P_0) vs x, absorption coefficient (μ) is determined







The spectral response of air column is given by

$$(P-P_0) = h\gamma = hc/\lambda \qquad \ldots (3)$$

$$\Lambda = hc/ (P-P_0) \qquad \ldots (4)$$

Where h=planks constant=6.62607004×10^{-34} Js,

c=velocity of light=3×10^{8} m/s.

Thus from eqn (4) spectral response of air column can be determined.

Theoretical fitting for data λ^{-1} vs x gives solar spectral response/ fitting for lower troposphere layer 0-0.2 km from ground

Lower tropospheric modelling:

Thus knowing μ, at different heights from ground wavelengths emitted can be modeled using following equation

$$\lambda^{-1} = [1.5065x10^{21} (e^{-\mu x} - 1)] \quad \text{...... (5)}$$

3. Result

1) Thus the absorption coefficient for ambient atmosphere is found to be 0.0053/cm
2) Eqn (4) identifies species like **NeII&VII, ArII, FeXV, OII, KII, NII** etc radicals are found in the lower tropospheric atmosphere

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