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Solar irradiance modelling-lower tropospheric profile

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Abstract: Solar radiation can be used as an effective tool to determine atmospheric composition and thus indoor / lower tropospheric irradiance modelling can be done. Here is a case study of an area (Lab3,dept of physics, NTU,NT road, Bangalore, Karnataka, India).This study helped to identify the radicals / ions active in spectral region, 400 to 700 ^{0}A .If hazardous radicals of medical concern are found precautionary measures can be taken by intimating residents of this area to take caution.

1.INTRODUCTION:

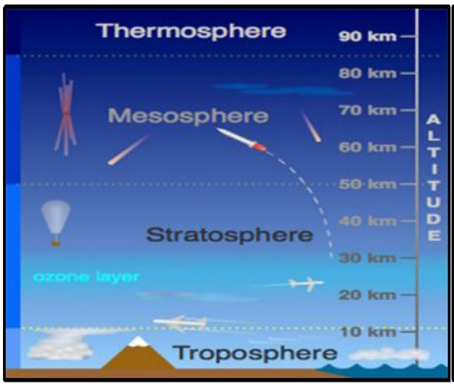

Fig 1

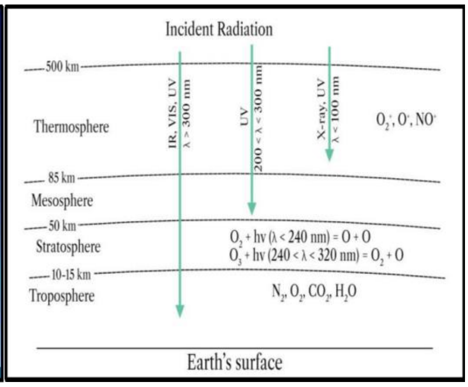

Fig 2

Earth atmosphere is consiting of layers

I.Troposphere It extends 0-10km with Composition N2,O2,CO2,H20

Solar radiations with λ >300nm (ie IR,VISSIBLE ,UV) enters this region

II.Stratosphere It extends 10-50km with Composition O+O, O2+O

Solar radiations with wavelengths less than 200 nm grater than 300nm enetrs this region

III.Mesosphere it extends 50-85 km with composition O2, O3, H2O, O, O1D, H, OH, HO2, CH4, H2, and H2O2 .

IV.Thermosphere it extends to a height greater than 85km with composition O2,O,NO

X ray , UV radiations with λ<100nm eneters this region

V.Exosphere It is the outermost layer of the atmosphere.The zone where molecules and atoms escape into space is mentioned as the exosphere.It extends from the top of the thermosphere up to 10,000 km.

Most of our day today life activities are concentrated in lower tropospheric region 0-5km altitude.Hence it is worth to study the ambient charecterstics of lower troposhphere.The molecular species prasent in this layer is of atmost importance in our daily healthy life.The interactions of molecular species prasent in this layer with incoming radiation like solar radiation is studied and an effective theoretical modelling for lower tropospheric solar irradiance is obtained.

2. THEORY:

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 obtained.

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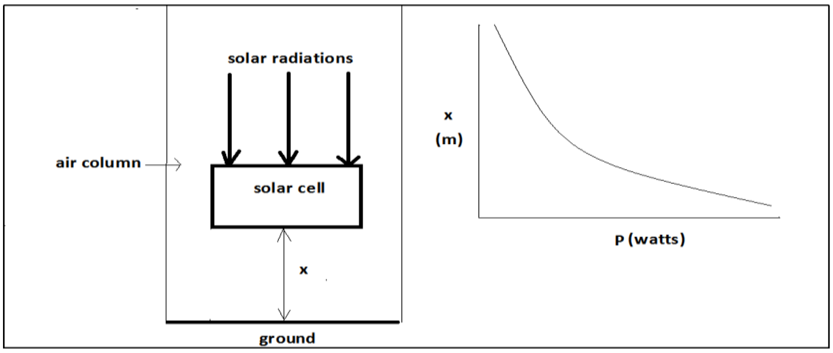

Fig3

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

$$P = P0\ \exp(-\mu x) \quad ....(1)$$

where **P**-power at the point of observation in joules
P_0-power above the air column in joules
μ- absorption coefficient of air
x-height of solar cell from ground/earth

$$\ln(P/P0) = -\mu x \quad .....(2)$$

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

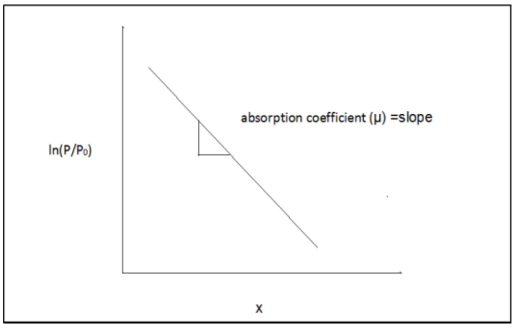

Fig4

The spectral response of air column is given by

$$(P - P0) = hv = hc/lambda \quad (3)$$

$$lambda = hc/(P - P0) \quad (4)$$

Where h=planks constant=6.62607004×10^{-34} Js
c=velocity of light=3×10^{8} m/s
Thus from eqn(4) spectral respone of air column can be determined Theoretical fitting for data of λ vs x gives solar spectral response fitting for lower troposphere layer 0-0.2 km from ground.

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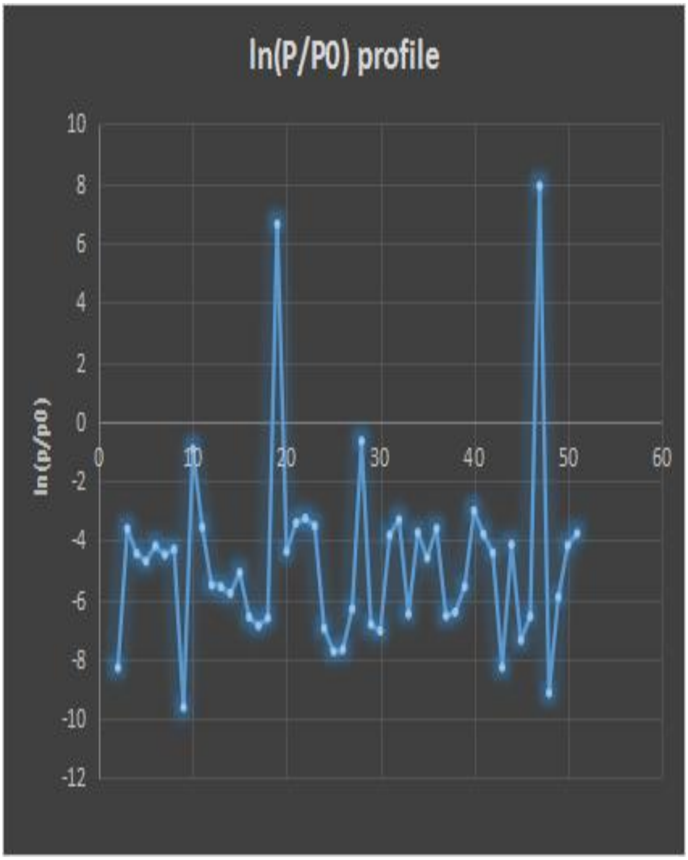

Fig5

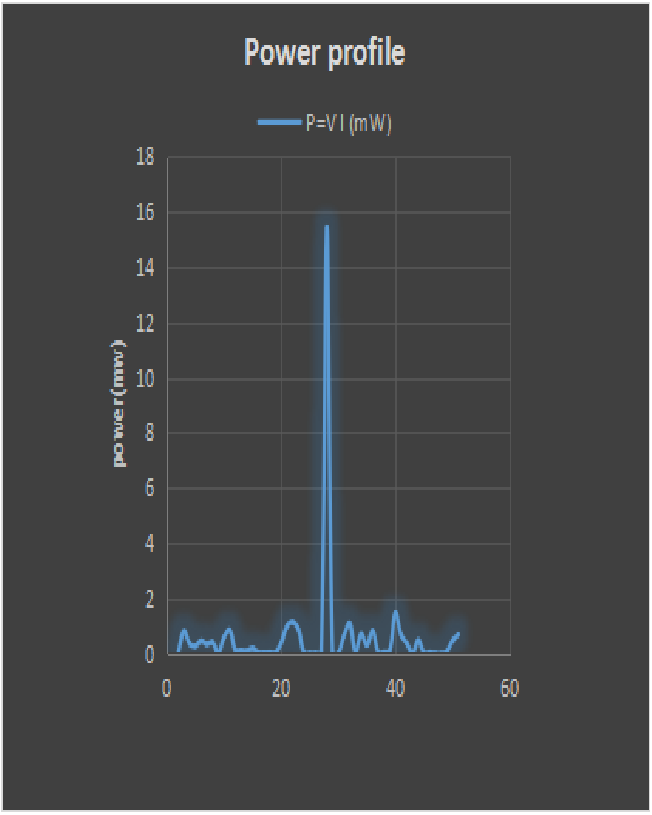

Fig6

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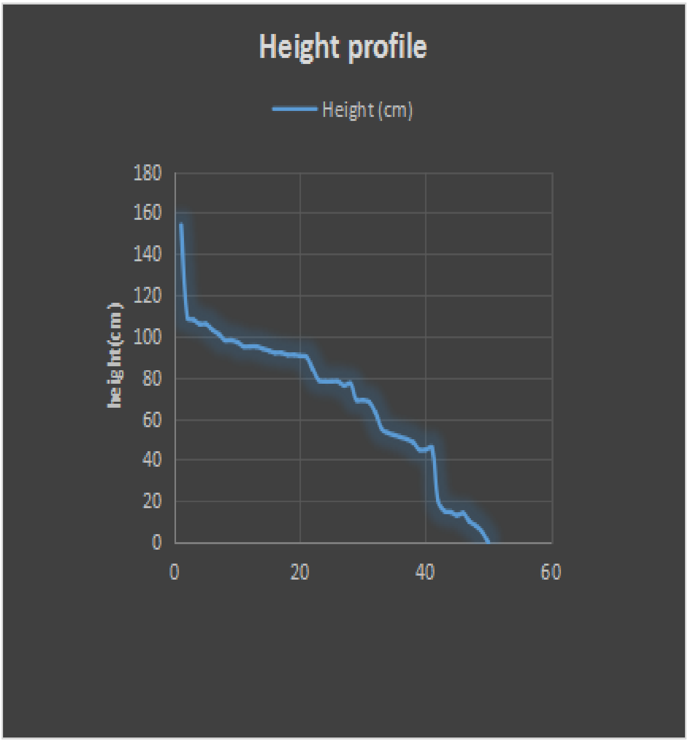

Fig7

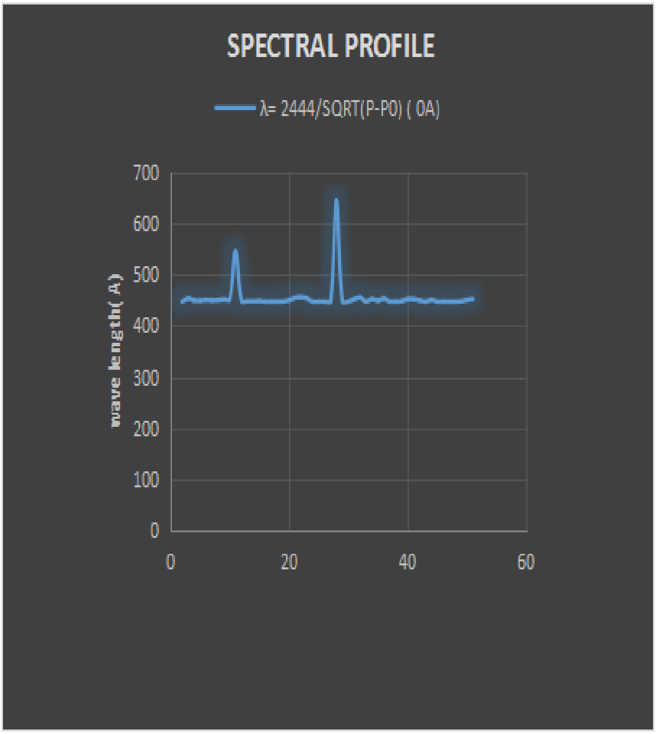

Fig8

Table 1

sno	Height (cm)	I (mA)	V (VOLT S)	P=V I (ev)	P_0 (ev)	ln(P/P0)	(P0-P) (ev)	λ= 2444/SQRT(P-P0) (^{0}A)	Ion species identifie d
1	154	0.25	0.03	0.0075	29.83	-	29.8225	447.5371	NeII

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						8.28906			
2	109	3.36	0.24	0.8064	29.83	-3.6114	29.0236	453.6848	NeVII
3	108	0.5	0.07	0.35	29.83	-4.446	29.48	450.0921	NeVII
4	106	1.79	0.15	0.2685	29.83	-4.7111	29.5615	449.5126	NeVII
5	106	2.52	0.18	0.4536	29.83	-4.1867	29.3764	450.9225	NeVII
6	103	2.1	0.16	0.336	29.83	-4.4869	29.494	450.0092	NeVII
7	101	2.39	0.17	0.4063	29.83	-4.2969	29.4237	450.5900	NeVII
8	98	0.33	0.06	0.0198	29.83	-9.6209	29.8102	451.9231	NeVII
9	98	3.07	0.19	0.5833	29.83	-0.9353	29.2467	451.9231	NeVII
10	**97**	**3.27**	**0.26**	**0.8502**	**29.83**	**-3.5585**	**28.9798**	**545.0219**	**Ar VI**
11	95	2.42	0.05	0.121	29.83	-5.5082	29.709	448.3581	FeXV
12	95	1.03	0.11	0.1133	29.83	-5.5739	29.7167	448.3581	FeXV
13	95	0.92	0.10	0.092	29.83	-5.7822	29.738	448.1937	FeXV
14	94	1.42	0.13	0.1846	29.83	-5.0858	29.6454	448.8522	FeXV
15	93	0.59	0.07	0.0413	29.83	-6.5831	29.7887	447.7831	NeII
16	92	0.44	0.07	0.0308	29.83	-6.8765	29.7992	447.7010	NeII
17	92	0.57	0.07	0.0399	29.83	-6.6176	29.7901	447.7831	NeII
18	91	0.56	0.07	0.0392	29.83	6.6353	29.7908	447.7831	NeII
19	91	2.09	0.18	0.3762	29.83	-4.3738	29.4538	450.3409	NeVII
20	90.5	4.46	0.22	0.9812	29.83	-3.4152	28.8488	455.0363	NEII
21	90	4.23	0.27	1.1421	29.83	-3.2633	28.6879	456.3107	NEII
22	84	3.41	0.26	0.8866	29.83	-3.5166	28.9434	454.2751	NEII
23	78.5	0.47	0.06	0.0282	29.83	-6.9646	29.8018	447.7010	NeII
24	78	0.26	0.05	0.013	29.83	-7.7390	29.817	447.6190	NeII
25	78	0.35	0.04	0.014	29.83	-7.6649	29.816	447.6190	NeII
26	78	0.68	0.08	0.0544	29.83	-6.3076	29.7756	447.8651	NeII
27	**76**	**5.15**	**3**	**15.45**	**29.83**	**-0.6586**	**14.38**	**644.5148**	**NII**
28	77	0.46	0.07	0.0322	29.83	-6.8319	29.7978	447.7010	NeII
29	69	0.43	0.06	0.0258	29.83	-7.0536	29.8042	447.7010	NeII
30	69	2.71	0.24	0.6504	29.83	-3.8264	29.1796	452.4250	NeVII
31	68	3.90	0.28	1.092	29.83	-3.3082	28.738	455.8851	NeVII
32	63	0.57	0.08	0.0456	29.83	-6.4841	29.7844	447.7831	NeII
33	55	2.62	0.27	0.7074	29.83	-3.7424	29.1226	452.8442	NeVII
34	53	2.16	0.14	0.3024	29.83	-4.5922	29.5276	449.7608	FeXV
35	52	3.87	0.21	0.8127	29.83	-3.6036	29.0173	453.6848	NeVII
36	51	0.61	0.07	0.0427	29.83	-6.5498	29.7873	447.7831	NeII
37	50	0.61	0.08	0.0488	29.83	-6.4162	29.7812	447.8651	NeII
38	48.5	1.04	0.11	0.1144	29.83	-5.5643	29.7156	448.3581	FeXV
39	45	6.16	0.24	1.4784	29.83	-3.0052	28.3516	452.5926	NeVII
40	45	3.36	0.20	0.672	29.83	-3.7937	29.158	452.5926	NeVII
41	46	2.1	0.17	0.357	29.83	-4.4262	29.473	450.1750	NeVII
42	20	0.19	0.04	0.0076	29.83	-8.2758	29.8224	447.5371	NeII
43	15	1.16	0.41	0.4756	29.83	-4.1394	29.3544	451.0890	NeVII
44	14.5	0.95	0.02	0.019	29.83	-7.3595	29.811	447.6190	NeII
45	13	0.47	0.09	0.0423	29.83	-6.5592	29.7877	447.7831	NeII
46	14	0.36	0.03	0.0108	29.83	7.9244	29.8192	447.5371	NeII
47	10	0.16	0.02	0.0032	29.83	-9.1408	29.8268	447.5371	NeII
48	8	0.9	0.09	0.081	29.83	-5.9095	29.749	448.1115	FeXV
49	5	1.92	0.24	0.4608	29.83	-4.1710	29.3692	451.0057	NeVII
50	0	3.62	0.19	0.6878	29.83	-3.7705	29.1422	452.7603	NeVII

4.CONCLUSIONS:

Two major absorption lines ,
545.0219 ^{0}A **($3s^2\,3p \rightarrow 3s\,3p^2;^2p_{1/2} \rightarrow ^2p_{3/2}$) Ar VI &** 644.5148 ^{0}A **($2s^2\,2p^2 \rightarrow 2s\,2p^3;\ ^3P_0 \rightarrow ^3S_1$) N II** are identified along with normal ambient absorption lines

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