International Journal of Research in Advent Technology, Vol.6, No.11, November 2018
E-ISSN: 2321-9637
Available online at www.ijrat.org

Solar UV Index and its dependence on Total Ozone for some Indian Stations – A Qualitative Review

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Abstract: Regular monitoring and analyzation of the profiles of atmospheric ozone was very essential for forecasting, modeling as well as monitoring of incoming ultraviolet radiation in day to day life. It is evident that the role of ozone has become significant in view of its effect on solar ultraviolet radiation. As the role of measurements made by instruments aboard satellites are highly correlated with the ground based measurements an attempt is made to review the relation between Total Ozone Content and UV Index for some Indian stations with the help of TEMIS (Tropospheric Emission Monitoring Instrument) and OMI (Ozone Monitoring Instrument) for the period 2005 to 2014.
Keywords: TOC, UVI, TEMIS and OMI.

1. INTRODUCTION

Measurements obtained from ground based instruments, flown on balloons, and operations in space have indicated that ozone concentrations are much higher between 15 and 30 km. Ozone production and destruction is a cyclic process with overall amount of ozone being stable. Enhancements in stratospheric chlorine and bromine have unbalanced leading to fall in ozone level. For the last three decades researchers and scientists have observed that stratospheric ozone is depleting as a result of anthropogenic polluting agents like halogen radicals such as chlorine and bromine.

Although sun emits a maximum radiation of wide spectrum, the ultraviolet radiation contributes a small part of it. Also solar ultraviolet radiation that reach earth's surface is based on various parameters. Radiative transfer calculations show that the intensity with which solar UV-B radiation reaches the earch surface mainly depends on the concentration of ozone.[3]. Previous analysis have clearly indicated that total column ozone and UV radiation are inversely related. In majority locations change in uv radiation is comparatively different than expected with reference to change in ozone only. This might be due to change in aerosols and other parameters like snow cover and clouds on long term basis. This is purely an indication of interaction taking place between change in climate and corresponding ultraviolet radiation.

2. UV-RADIATION

It is a known fact that sun radiation comprises of different wavelengths and the energy of radiation is classified by wavelength. In this uvb radiation (280-315nm) is of more importance due to its impact on human as well as animals, agriculture etc. One of the factors that influence the incoming uv radiation on to earth's surface is commonly termed as column ozone. Column Ozone is the total amount of ozone present in a column between the earth's surface and the top of the stratosphere which is expressed in Dobson Units. As per the World Health Organization nomenclature measure of uv-b radiation is defined by a parameter known as UVI(uv index) and the value of UVI denotes the concentration of radiation. The range of UV Index is shown in the table below.

An attempt was made to study the variation of column ozone (TOC) and UV radiation (UVI) received

S. No	Range of UV Index	Corresponding Risk
1	1 - 2	Minimum
2	3 - 4	Low
3	5 - 6	Moderate
4	7 - 9	High
5	10 and >> 10	Very High

Table 1. Table showing Risk vs. UV Index as per World Health Organization

Chennai				Hyderabad				Pune		
Year	**Ozone(DU)**	**Mean UVI**		**Year**	**Ozone(DU)**	**Mean UVI**		**Year**	**Ozone(DU)**	**Mean UVI**
2005	257	11.45		2005	262	11.01		2005	265	10.88
2006	262	11.3		2006	265	11.03		2006	268	10.93
2007	263	11.55		2007	268	11.1		2007	271	11.02
2008	264	11.33		2008	264	11.13		2008	266	11.07
2009	262	11.25		2009	267	10.89		2009	270	10.77
2010	261	11.35		2010	262	10.93		2010	266	10.83
2011	263	11.9		2011	267	10.8		2011	270	10.72
2012	263	11.39		2012	272	10.93		2012	270	10.79
2013	267	11.23		2013	269	10.96		2013	266	10.87
2014	265	11.05		2014	273	10.63		2014	271	10.45
Mumbai				**Kolkatta**				**Bhopal**		
2005	264	10.5		2005	269	9.72		2005	271	9.72
2006	266	10.54		2006	275	9.74		2006	270	9.78
2007	270	10.63		2007	267	9.78		2007	277	9.86
2008	265	10.69		2008	271	9.95		2008	269	9.97
2009	268	10.39		2009	271	9.7		2009	273	9.7
2010	264	10.44		2010	272	9.6		2010	273	9.61
2011	268	10.33		2011	272	9.64		2011	273	9.66
2012	269	10.39		2012	273	9.67		2012	274	9.68
2013	266	10.49		2013	272	9.66		2013	268	9.78
2014	271	10.07		2014	279	9.53		2014	275	9.45
Ahmedabad				**Delhi**				**Srinagar**		
2005	272	9.56		2005	282	8.17		2005	297	7.69
2006	271	9.62		2006	281	8.24		2006	299	7.87
2007	277	9.75		2007	289	8.36		2007	302	8.04
2008	271	9.82		2008	278	8.43		2008	292	8.01
2009	273	9.58		2009	280	8.42		2009	292	7.7
2010	273	9.52		2010	287	8.09		2010	309	7.64
2011	274	9.56		2011	280	8.34		2011	291	8
2012	275	9.52		2012	282	8.25		2012	294	7.96
2013	270	9.6		2013	277	8.36		2013	294	8.16
2014	276	9.29		2014	284	8.1		2014	299	7.86

Table 2. Variation of ozone and UVI for nine Indian Stations

S.No	Station	Latitude	Max TOC(DU)	UVI(%)
1	Chennai	13.08	270	52
2	Hyderabad	17.37	260	31
3	Pune	18.53	280	31
4	Mumbai	19.08	280	35
5	Kolkatta	22.34	280	22
6	Bhopal	23.28	290	27
7	Ahmedabad	23.09	280	33
8	Delhi	29.01	275	25
9	Srinagar	34.08	290	16

Table 3. Station wise maximum ozone and corresponding UVI risk

by earth over India during 2005-2014 for stations available in the websites of Tropospheric Emission Monitoring Internet Service (TEMIS) http://www.temis.nl/ which gives the near real time satellite data products of atmospheric composition and NASA monitored OMI satellite data given by http://aura.gsfc.nasa.gov/instruments/omi.html

3. DATA

UVI data used in the present study was retrieved from TEMIS and TOC data was retrieved from OMI mentioned above. Daily values of data were taken from which annual and monthly means are obtained for selected stations located in India.

4. RESULTS & DISCUSSION

4.1. Variation of Total Ozone Content and UV Index over decade

Annually means for years 2005 to 2014 was calculated from the values of column ozone and uv index obtained from the satellite data and is given in the order of increasing latitude of nine Indian stations. The data indicate the mean values of TOC and UVI for various Indian stations as per the increasing order of latitude. The data also indicate a decrease in UV index with increase in latitude with corresponding increase in ozone. The same trend is observed for all the years from 2005-2014. This increase in uv radiation is due to increase in ozone and also solar zenith angle. The variation in total ozone and UVI for northern region is larger than southern region. The lowest latitude station Chennai and highest latitude station Srinagar have a variation in total ozone ranging from 260 DU to 300 DU and UVI ranging from 11 to 7. A change of 43 DU with uv index falling by 50% of its value from 10.65 to 4.6 for the period 2006-2010 has been reported.(K. Elampari et.al.,2013) However here for a change of 40 DU ozone UVI is found to reduce only by 4. The reason may be purely based on local conditions that influence ultraviolet radiation indirectly in addition to reduction of ozone. All the stations show very similar yearly averages throughout the year despite their difference in latitude.

4.2. Frequency Distribution of TOC and UVI

Analysis of satellite measured TOC and UVI for different Indian stations during 2005-2014 as per the risk factor related to UV radiation indicate the % high risk above UV index 11 for various stations. Here it is clearly observed that the ozone Chennai faces high risk with 52 % and Srinagar faces lowest risk with 16 % frequency.

4.3. Latitude wise distribution of TOC and UVI

From Table 3 it is evident that Chennai and Hyderabad (low latitude regions of India) receives very high and Extreme UV radiation for most of the days because of the low ozone content over these regions. Chennai has only Very High and Extreme Index values during the entire period. On the other hand, because of high total ozone content over the northern regions of India, Ahmadabad, Delhi and Srinagar regions have received Moderate and Lower UV radiations.

5. CONCLUSION

UV-B radiation in terms of UV Index and its dependence on Total ozone content over different regions of India has been reported. The report clearly shows that the change in total ozone and UVI for northern region is larger than southern regions. The lowest latitude station Chennai and highest latitude station Srinagar have a variation in total ozone ranging from 260 DU to 300 DU and UVI ranging from 11 to 7.

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