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Ozone and Aerosol Index as radiation amplification factor of UV index over Egypt based on satellite data in period (1979-2005)

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Abstract: *The increasing amount of UV Index (UVI) (in percentage) when 1% decreases in the column of atmospheric ozone known as Radiation Amplification Factor (RAF). RAF is a very useful quantity to estimate the climatic change. The study covers the period from 1979 to 2005, with a missing data from 1993 to 1996. In the first, these parameters (Ozone, AI and Reflectivity (REF)) are studied individually over all sky conditions. The radiation amplification factor (RAF) will be studied over cloudless sky conditions for clarification of the relativity ratio between total ozone content (TOC) and Ultraviolet index (UVI) also for estimation of the dependence of UVI by aerosol index. RAF of UVI due to changes in TOC by 1% corresponding by variation in UVI by 0.83 % – 1.07%, While the RAF due to changes in Aerosol Index by 1% corresponding by variation in UVI variation by 0.007 % – 0.07%.*

I. Introduction

The increasing amount of UV (in percentage) when 1% decreases in the column of atmospheric ozone known as Radiation Amplification Factor (RAF). RAF is a very useful quantity to estimate the climatic change. Unfortunately, due to a non linear relation between UV and ozone for larger ozone changes the RAF only used to estimate the effect of small ozone changes. RAF may be calculated by the following equation:

$UVI = k \times TOC^{-RAF}$ ………………………….(1)

Where k is related to other atmospheric constituents that also affected on UVI such as cloudiness, aerosols and pollution (McKenzie et al., 1991[1]; Madronich, 1993[2], [3]; Bodhaine et al.,1997[4]; Madronich et al., 1998[5]; Dubrovsky, 2000[6]; Zerefos, 2002[7], Serrano et al., 2008[8], Anton et al., 2009[9]).

To satisfy equation (1), cloudless sky condition must be considered where:

1- The Clear sky cases (REF ≤10%).
2- Lowest solar zenith angle.

RAF was estimated in Upper Egypt in period (1979-2000), RAF was varied from 0.96 to 1.06 and from 0.96 to 1.02 and from 1.03 to 1.09 at western desert, river Nile and red sea regions receptivity (El-Nobi E. F., 2012[10]).

In case of relation between UVI and Aerosol Index the RAF follows the equation:

$UVI = c \times AI^{-RAF(AI)}$ ………………………….(2)

Where c is related to other atmospheric constituents that also affected on UV (Krzyścin, 2011[11];Kim et al, 2008[12]).

To satisfy equation (1), cloudless sky condition must be considered where:

1- The Clear sky cases (REF ≤10%).
2- Lowest solar zenith angle.
3- Lowest values of TOC.

II. Discussion

1. Radiation Amplification Factor (RAF) due to TOC

The increasing amount of UV (in percentage) when 1% decreases in the column of atmospheric ozone known as Radiation Amplification Factor (RAF). RAF is a very useful quantity to estimate the climatic change. Unfortunately, due to a non linear relation between UV and ozone for larger ozone changes the RAF only used to estimate the effect of small ozone changes. (Madronich et al. 1998[5], Serrano et al., 2008[8]; Anton et al., 2009 [9]) give the RAF by the power form as in equation (3):

$UVI = k \times TOC^{-RAF}$ …………………………….(3)

Where k is related to other atmospheric constituents that also affected on UVI such as cloudiness, aerosols and pollution. To clarify the effect of TOC changes on UVI the other factors must be constant. Therefore, the Clear sky cases (REF ≤10%) and lowest solar zenith angle have been selected. Table (1) shows the correlation coefficients and RAF for Equation (3)

Table (1) The parameters of equation (3)

Site	Equation	RAF	R^2	r
M-mattroh	$y = 93103x^{-1.01}$	1.01	0.56	-0.75
Bort-saaed	$y = 12931x^{-1.07}$	1.07	0.564	-0.75
Alexandria	$y = 10052x^{-1.03}$	1.03	0.56	-0.75
Arish	$y = 97205x^{-1.02}$	1.02	0.536	-0.73
El-Esmaelia	$y = 82823x^{-0.99}$	0.99	0.485	-0.7
Cairo	$y = 10498x^{-1.03}$	1.03	0.51	-0.71
suez	$y = 66074x^{-0.95}$	0.95	0.49	-0.7
Giza	$y = 63413x^{-0.94}$	0.94	0.475	-0.69
Taba	$y = 47691x^{-0.89}$	0.89	0.435	-0.66
El-fayom	$y = 60182x^{-0.93}$	0.93	0.424	-0.65
S-Katreen	$y = 85047x^{-0.99}$	0.99	0.403	-0.63
Eltour	$y = 73965x^{-0.96}$	0.96	0.376	-0.61
Elmenia	$y = 62601x^{-0.94}$	0.94	0.432	-0.66
Sharm	$y = 41025x^{-0.86}$	0.86	0.334	-0.58
Hurghada	$y = 62027x^{-0.93}$	0.93	0.406	-0.64
Assyut	$y = 41178x^{-0.86}$	0.86	0.385	-0.62
Sohag	$y = 48752x^{-0.89}$	0.89	0.392	-0.63
Qena	$y = 49079x^{-0.89}$	0.89	0.349	-0.59
Elkharga	$y = 35116x^{-0.83}$	0.83	0.293	-0.54
Aswan	$y = 44828x^{-0.88}$	0.88	0.29	-0.54
Abusembel	$y = 35926x^{-0.84}$	0.84	0.273	-0.52
Halaib	$y = 59650x^{-0.93}$	0.93	0.204	-0.45

It’s clearly from Table (1) and Figure (1) the inverse relation between UVI and TOC. The correlation coefficient varied from 0.2 to 0.56. RAF varied from 0.83 to 1.07 the same result reported by Madronich et al., 1998 [5]. This means that the changes in TOC by 1% corresponding by variation in UVI by 0.83 % – 1.07%.

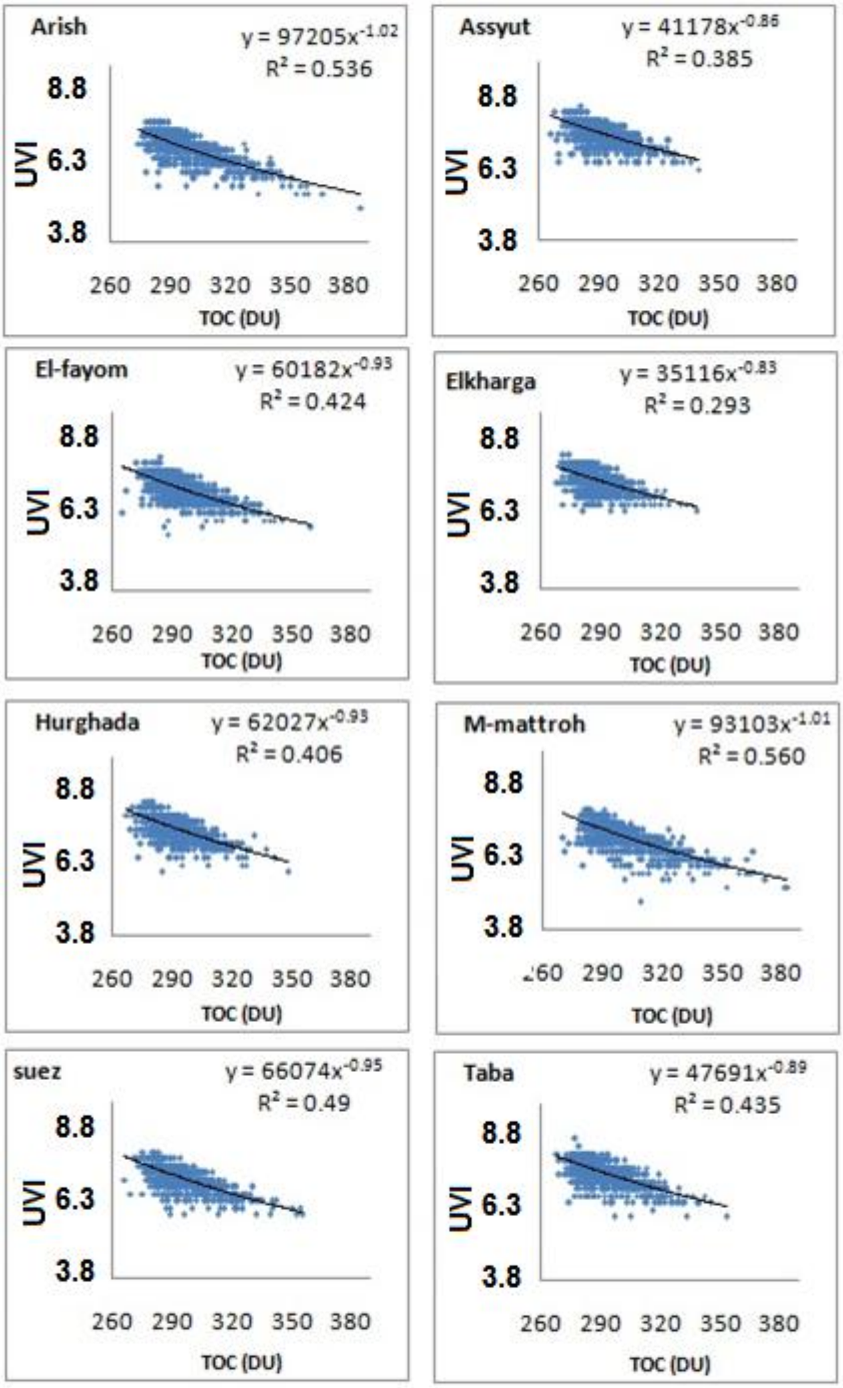

Fig. (1) The RAF of UVI due to TOC for some sits.

2. Radiation Amplification Factor (RAF) due to Aerosol Index

Radiation Amplification Factor (RAF) due to Aerosol Index is the increasing amount of UV (in percentage) when 1% decreases in the Aerosol Index. To clarify the effect of AI changes on UVI the other factors must be constant. Therefore, the Clear sky cases (REF ≤10%), lowest solar zenith angle and lowest values of TOC have been selected. (Krzyścin, 2011[11]; Kim et al, 2008[12]) give the RAF by the power form of RAF as in equation (4):

$$UVI = b \times AI^{-(RAFAI)} \qquad \text{……………………………(4)}$$

Where b is related to other atmospheric constituents that also affected on UVI such as TOC, SZA, albedo and cloudiness. Table (2) shows the correlation coefficients and RAF for Equations (4). It's clearly from Table (2) and Figure (2) the inverse relation between UVI and AI. The correlation coefficient varied from 0.009 to 0.62.

RAF varied from 0.007 to 0.07 the same result reported by Madronich et al., 1998. This means that the changes in AI by 1% corresponding by variation in UVI by 0.007 % – 0.07%.

Table (2) The parameters of equation (4)

Site	Equation	RAF(AI)	R^2	r
M-mattroh	$y = 297.9x^{-0.02}$	0.02	0.083	-0.29
Bort-saaed	$y = 300.7x^{-0.04}$	0.04	0.504	-0.71
Alexandria	$y = 299.422x^{-0.007}$	0.007	0.009	-0.09
Arish	$y = 298.5x^{-0.04}$	0.04	0.388	-0.62
El-Esmaelia	$y = 307.8x^{-0.05}$	0.05	0.382	-0.62
Cairo	$y = 301.8x^{-0.03}$	0.03	0.166	-0.41
suez	$y = 311.8x^{-0.05}$	0.05	0.398	-0.63
Giza	$y = 308.4x^{-0.06}$	0.06	0.514	-0.72
Taba	$y = 320.1x^{-0.07}$	0.07	0.345	-0.59
El-fayom	$y = 312.4x^{-0.06}$	0.06	0.504	-0.71
S-Katreen	$y = 318.7x^{-0.05}$	0.05	0.284	-0.53
Eltour	$y = 319.1x^{-0.05}$	0.05	0.347	-0.59
Elmenia	$y = 312.8x^{-0.05}$	0.05	0.453	-0.67
Sharm	$y = 308.7x^{-0.05}$	0.05	0.497	-0.7
Hurghada	$y = 316.2x^{-0.05}$	0.05	0.401	-0.63
Assyut	$y = 319.6x^{-0.06}$	0.06	0.411	-0.64
Sohag	$y = 317.9x^{-0.05}$	0.05	0.413	-0.64
Qena	$y = 319.3x^{-0.06}$	0.06	0.492	-0.7
Elkharga	$y = 319.4x^{-0.06}$	0.06	0.427	-0.65
Aswan	$y = 318.3x^{-0.05}$	0.05	0.507	-0.71
Abusembel	$y = 320.1x^{-0.05}$	0.05	0.508	-0.71
Halaib	$y = 319.0x^{-0.07}$	0.07	0.623	-0.79

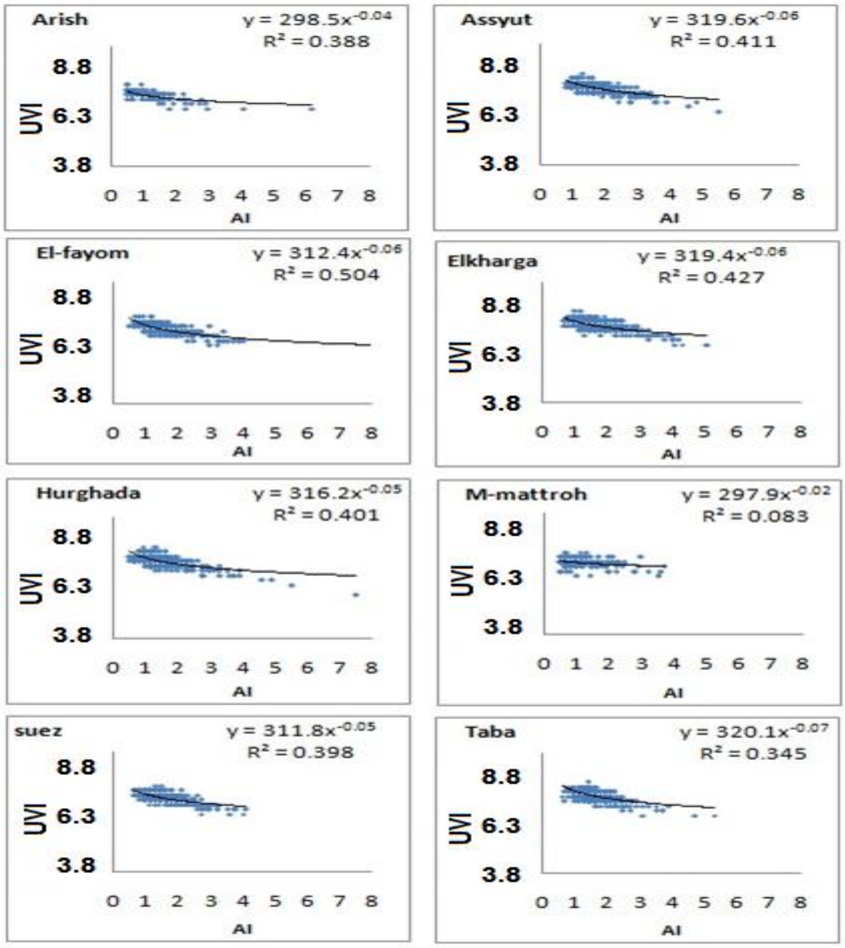

Fig. (2) The RAF of UVI due to AI for some sites.

III. Conclusion

By using the available data:

1- The changes in TOC by 1% corresponding by variation in UVI by 0.83 % – 1.07%.
2- The changes in AI by 1% corresponding by variation in UVI by 0.007 % – 0.07%.

The same result reported by Madronich et al., 1998.

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