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# An investigation of atmospheric turbidity of sixteen Iraq location

حساب عكورة الجو إلى ستة عشر موقعاً جغرافياً

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## Abstract:

Using sunshine duration, extraterrestal radiation and globle radiation as in put of some mathematical models, The average daily diffused solar radiation and atmospheric turbidity in various (16) placed around of Iraq are estimated by using a thirty years solar radiation data the period from ( 1961 – 1991 ).The diffused solar radiation have a maximum values are appeared in the summer season ( April, may, Jun, July and August) were found to range from( 5 - 7.5 MJ. $M^{-2}$ $day^{-1}$ ) while the minimum values in the other months. The turbidity values were found to range from 0.233 to 0.313 and the overall average ($\tau$ ) was 0.269. The minimum value in Al- Hai 0-233 and the maximum value was 0.313 in Zakho. The low values of ($\tau$ ) indicate that the Iraqi sky has relatively small disturbance and pollutant in the atmosphere. The correlation between the ($\tau$ ) and geographical coordination have been shown a weak relation between them.

Key worlds: Atmospheric turbidity, Angstrom coefficient

**الخلاصة :**

استعملت ساعات السطوع والإشعاع الشمسي الخارجي والإشعاع الكلي كمدخلات في بعض النماذج الرياضية , وحُسب معدل الإشعاع المنتشر وعكورة الجو إلى ستة عشر موقعاً عراقياً متغيراً باستخدام معطيات الإشعاع الشمسي إلى ثلاثين عاماً من الفترة ( 1961 – 1991م ). القيم العظمى للإشعاع المنتشر ظهرت في فصل الصيف للأشهر (نيسان ، آيار ، حزيران ، تموز ، آب ) وكان المعدل من ( 5- 7.5 ميكا جول $^{-2}$. يوم $^{-1}$) بينما القيم الصغرى في الأشهر الأخرى أما قيم مدى العكورة ( 0.233 – 0.313 ) ومعدلها الكلي حوالي ( 0.269 ) أقل قيمة في منطقة الحي ( محافظة واسط ) ومقدارها ( 0.233 ) وأعلى قيمة في زاخو ( 0.313 ) إن القيم الصغرى تشير إلى أن الجو في العراق ذات توزيع صغير نسبياً بالنسبة للتلوث والارتباط بين العكورة ( $\tau$ ) والظروف الجغرافية ضعيف نسبياً.

## 1. Introduction:

The Sun is immense fusion reactor ( fusion) simply means that hydrogen atoms are combined to make helium. This occurs on the sun because it is very hot. The Sun's unclear fusion process converts 508 million tons of hydrogen into 504 million tons of helium every second. The remaining 4 million tons matter are converted to energy [1]. The solar radiation received at the top of the earth's atmospheric on horizontal surface is called the extraterrestrial solar radiation ( Ra) [2,3]. The Sun light reaching the ground is usually reduced by dirt such as dust, haze ,aerosol particles and water vapor[4]. Aerosols in atmospheric ( which include sulfate black carbon, organic carbon, mineral dust, sea – salt, volcanic ash, pollen, nitrate and ammonium) evolve in size and composition by homogenous and heterogeneous nucleation, condensation, coagulation as well as dry and wet deposition. On one hand, aerosol absorbed and scatter radiation, this parameter study by [5]. In South Africa estimate the monthly a verged atmospheric turbidity from surface climate data at eight location[6]. The relationship between the aerosol optical depth with relative humidity and wavelength studied by [7]. The atmospheric turbidity calculated and averaged for 29 places around the king dome of Saudi

Arabia, The turbidity values were found to rang from 0.1 to 0.4.[4] In the present work to calculate the turbidity coefficient ($\tau$) for the sky of Iraq dependent on the solar radiation.

## 2. Theory:

The data includes the monthly mean of daily extraterrestrial radiation (Ra) for each day of year and for different latitude can be estimated from the solar constant, the solar declination and time of year.[2,3]

$R_a = \underline{24(60)}\ G_{sc}\ d_r\ [\ w_s \sin(\varphi)\sin(\delta) + \cos(\varphi)\cos(\delta)\sin w_s]$ (1)

$R_a$=extraterrestrial radiation [ MJ. $m^{-2}$. $Day^{-1}$]
$G_{sc}$ = solar constant 0.082 [M $J.m^{-2}$ –min $^{-1}$]
$d_r$ = inverse related distance, Earth- Sun
$W_s$ = Sun set hour angle [ rad]
$\varphi$ =latitude [ rad]
$\delta$ = solar declination [ rad]

The solar shortwave radiation ($R_s$) can be calculated with Angstrom formula with relates solar radiation to extraterrestrial radiation and relative sunshine duration as follow;

$$Rs = (as + bs\frac{n}{N})Ra \quad (2)$$

$R_s$ = solar shortwave radiation [MJ. $M^{-2}$. $day^{-1}$]
or global radiation.
n= actual duration of sunshine [ hour]
N= maximum possible duration of sunshine or daylight hour [hour]
n /N = relative sunshine duration.
$a_s + b_s$ = fraction of $R_a$ reaching the earth on clear day [N=n]

Turbidity is used to quantity the attenuation by aerosols that is responsible for increasing the ratio of diffused to the total solar radiation as well as responsible changing the spectral composition. There are three types of turbidity (1) link turbidity factor ( Tl ) the normal values varies from 0 to 10. Link turbidity factor refers to the whole spectrum, that is overall spectrally integrated attenuation, and account for presence of water vapor and aerosols in atmosphere. (II) Angstrom turbidity coefficient ($\tau$) is obtained from spectral measurement. The index indicates only amount of aerosols present in atmosphere. The value of ($\tau$) varies typically from 0 to 0.5.(III), illuminace turbidity factor (Ti), the concept of (Ti) is analogous to that (Ti) factor [8]. The turbidity ($\tau$) dependent on the diffused solar radiation (Rd), the Rd calculated by [7].

$R_d = R_s( 1.39 - 4.027C + 5.53\ C^2 - 3.108C^3 )$ (3)

$R_d$: diffused solar radiation
C = $R_s / R_a$ the clearness index.

The turbidity ($\tau$) can be expression by

$$\tau = 1.47\left(\frac{Rd}{Rs} - o.1\right) \quad (4)$$

Where 1.47 is the sea water ratio [$Na^+ + K^+ + Mg^+ + ca^+ + So^= + HCo_3 / Na^-$ ] [5].

## 3.Results and Discussion:

Iraq lies between latitudes 29º. 5ó and 37º.22ó north and between longitude 38º 45ó east and 48º 45ó east. The stations selected in our present study are. The Ra , Rs and sunshine duration data reported in this paper were supplied by relevant meteorological and solar radiation data were mainly taken from the Republic of Iraq Meteorological office ( RIMO). The measured values in a period (1961 – 1992) for all station this result obtained by using the equations ( 1 to 4). Ra and N were evaluated by the equation (1) and (2) , table (1,2) respectively. Here Rs represent the daily global radiation to estimate by equation (2), table(3). $a_s$ and $b_s$ the constant coefficients which is believed to applicable at any where in world ( $a_s$ = 0.25, $b_s$=0.5) [2]. Using the equation (3) to calculate the diffused solar radiation (Rd) table (4). The maximum values for all locations are observed in April, May, Jun, July, and August, while the minimum values appeared in January, February, November and December, this changing duo to turbidity factor and seasonal variation which dependent on the position of the sun. fig. (1)

The values of turbidity ($\tau$ ) were in the range 0.233 to 0.313 for all selected locations. Table (5).

The overall averaged of ($\tau$ ) ( mean overage of all stations ) in Iraq was 0.296. Figs ( 2,a,b,c,d) explained the variation of turbidity for all location with months, from Fig. (3)

Observed the maximum average value of ($\tau$ ) in Zakho and Kirkuk Cities ( Northern of Iraq), 0.313 and 0.295 respectively, while the minimum ($\tau$ ) in AL- Hai city ( Middle of Iraq) was 0.233.

The high value of ($\tau$ ) depend on the locations industrial city and nearest from the desert. From table (5) it is clearly seen that each station has it's own individual trend. The our results have shown the maximum values in the summer season. The turbidity of Iraq smaller than of ($\tau$ ) of Saudi Arabia which mean that the Iraq sky's has small amount of aerosol and sky pollution in atmosphere and the average range of ($\tau$ ) is normally value table (6).

## 4. conclusions:

The study provides Models for calculation of radiation data(Ra , Rs , Rd ……) on daily base for any location in Iraq. The result show that the diffused solar radiation decreases in winter and increases in summer. The radiation intensity of (Rd) depends on the variable position of the sun, Rayleigh dispersion on pure air molecule extinction by vapor particle and albedo of ground. The values of the turbidity ($\tau$ ) of the atmosphere are found vary with seasons and month, with difference further station. Turbidity in Iraq was found to be low compared with the Saudi Arabian. Over recent decades, turbidity has generally been stable at most stations in Iraq, but exceptions has been an increase in turbidity future. The low values of ($\tau$ ) indicate that Iraq's sky has a relatively small pollutant and disturbance.

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