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Global And Ultravoilet Radiation Over Kuwait

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الإشعاع الكلي والفوق البنفسجي الساقط على الكويت

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تم قياس ست حزم طيفية للإشعاع الشمسي الساقط على دولة الكويت خلال الفترة من ١ مايو ١٩٩٥ حتى فبراير ١٩٩٨م، وتم ملاحظة أن مقدار الحزم الإشعاعية ذات الأطوال الموجية القريبة من الإشاعة الفوق بنفسجية كانت قليلة خلال السنوات الثلاث الماضية عند مقارنتها مع تلك المقاسة في مناطق أخرى تقع على خط عرض مساو لدولة الكويت (٢٩ درجة شمالاً). هذا يعني أن الإشعاع الشمسي الفوق بنفسجي قد تم امتصاصه في جو الكويت بنسبة أكثر من المواقع الأخرى. أما الإشعاع الشمسي الكلي المسجل في الكويت فمقداره يفوق ذلك المسجل في مناطق أخرى لها نفس خط العرض، وفي هذا البحث تم كذلك قياس النسبة بين الإشعاع الشمسي المنتشر الى الكلي (D/ G) خلال الفترة من ١ مايو ١٩٩٥ حتى ٥ فبراير ١٩٩٨م نظراً لأهميتها في التعرف على نسبة تلوث الجو في الكويت. كما تم قياس قيمة الانعكاسية (الالبيدو) الأرضية خلال هذه الفترة من الوقت حيث كانت قيمة ميل المنحي مع التغير في درجات الحرارة سلبياً.

KEY WORDS : Global radiation, Ultraviolet radiation, Diffuse radiation, Pollution, Ground Albedo

ABSTRACT

The data of six spectral bands of solar radiation over Kuwait were measured locally, during the period of time starting May 1, 1995 until February 5,1998.

Near ultraviolet spectral band (315-380) nm, shows very week measurements during the last 3-years, compared with

other measured regions. This means that the solar ultraviolet radiation was absorbed in Kuwaiti Atmosphere. The Global radiation is high in Kuwait's atmosphere, when compared with other places, have the same Kuwait's Latitude (29 north). The variation of the ratio of diffuse and global solar radiation (D/G) was also measured during this period. This ratio provides refer within about the level of the pollution in Kuwaiti atmosphere. The pollution was slightly less during years 1996 and 1997. The ground Albedo was measured during this period of time, and shows a negative slope with surface temperature.

INTRODUCTION

Solar radiation, passing through the earth's atmosphere, undergoes a complicated transformation, absorption and scattering of radiation energy. The sum of the vertical component of direct and diffuse solar radiation represents the global solar radiation. It is partly reflected by the earth's surface. Global solar radiation is recorded at many stations in the Middle East, but information about its spectral bands, is still poor. Kelien and Goldberg measurement [1], shows that the monthly ratios vary significantly from place to place. Ultraviolet solar radiation at Dhahran, Saudi Arabia was analyzed by El-Hadidy et al [2]. The relation between global and ultraviolet solar radiation was studied earlier in Kuwait by Al-Aruri [3]. The solar radiation was measured too, in places having nearly similar latitude (φ) to Kuwait [4], [5]. The Global and Ultraviolet solar radiation were measured in Cairo and Aswan (Egypt) during three years (1990-1992), by Shaltout M. A. ,et al. [4]. He found the ratio of the ultraviolet to the global radiation (UV/G) range between 2.7% in winter to 3.4% in summer for Cairo/Egypt (Latitude, 30°). The analytical studies of solar radiation in different spectral bands are so important for local measurements at Middle East. It provides analogy information about the type of pollution in the atmosphere. Long-term changes in solar Ultra-Violet radiation were measured in Bahrain, Alnaser W. E. [5]. In that paper, An empirical equation has been developed to estimates the solar Ultra-Violet radiation for Bahrain. Periodical analysis of solar radiation at Kuwait and the climate effects were given by Hady A. [6]. The studies of solar irradiation falling on Kuwait and its effects on the efficiency of photovoltaic cells were shown Hady A. [7]. The study of the relation between Global and diffuse solar radiation in Bahrain was given by Alnaser W. E. [8]. This paper can give us a good indication of the level of pollution. The study of intensity variation of daily ultraviolet radiation measured during years 1986,1987 over Kuwait were given by Al-Aruri et al. [9].

In this work, The data of six spectral bands of solar radiation were collected at one site (at Kuwait), during the period of time started May 1, 1995 until Feb. 4,1998. The study of the pollution level in Kuwaiti atmosphere was given according to this solar radiation data. The Ground Albedo as a function of surface temperature was given too.

DATA ANALYSIS AND DISCUSSIONS

Data Collection:

The data have been collected at the College of Technological Studies, (PAAET) in Kuwait, at the Solar Energy Laboratory site. Instrument of type SKr-1850, (United Kingdom), containing system of detection and Integral Amplifier were used for radiation measurements and weather parameters data collection. Automatically by data logger, the data were transferred every one hour and recorded in PC files.

The data were collected during the last 3 years, starting on May 1, 1995. Using six-channels corresponding to the six solar radiationís bands collected the solar radiation in our site. Our measurements covering the wavelength regions (400-500 nm), (500-600 nm) and (600-700 nm) in the Visible region, where these bands lies in Second atmospheric window. The spectral regions (600-700 nm) and (700-800 nm) lie in the near Infrared spectral region,

which is a good indication for thermal energy falling on Kuwait. Near ultraviolet radiation band (315-380 nm), were given too, where Ultraviolet region subdivided to near ultraviolet region (300-400 nm) and far ultraviolet region, of (200-300 nm). These regions of Ultraviolet radiation are covering about 8.7% of solar radiation reaching the earth. Only the collected data of the solar irradiation were used for our analysis. Global and diffuse solar radiation were also measured during the last three years.

Global and Diffuse Radiation:

The solar radiation was recorded from a solid angle (2π) radians on a horizontal surface, refers to the global radiation. The variations of Global solar radiation on a horizontal surface was recorded during time series starting on May 1, 1995 until Feb. 5,1998. Diffuse radiation at the same period of time was given. Figure (1) shows the maximum intensity values of daily recorded variations of global solar radiation (higher curve), and daily Maximum Values of defuse solar radiation (lower curve), as a function of time interval starting on May 1, 1995 until Feb 5, 1998. The effects of seasonal and annual variation of this solar radiation had appeared in both curves in figure (1).

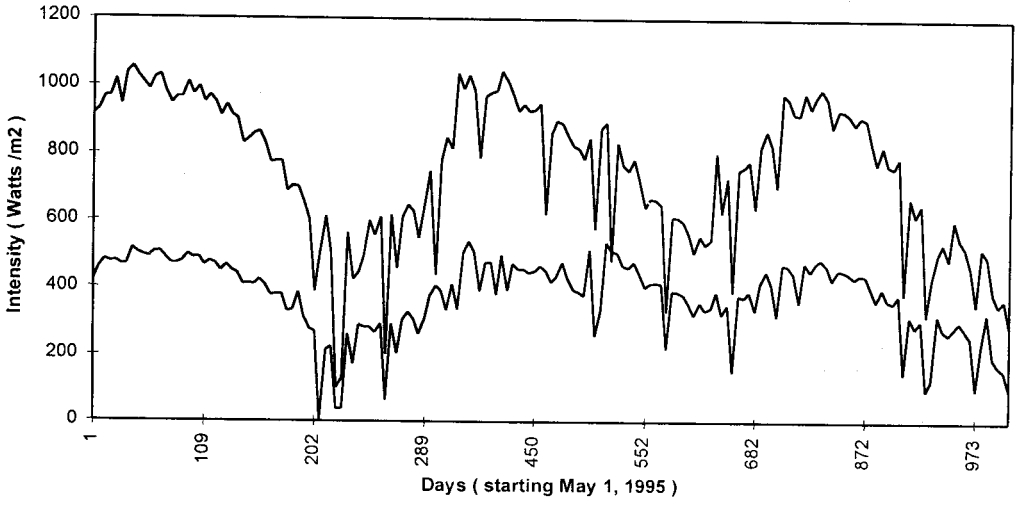

Figure (1), Maximum values of global radiation (higher curve), and diffuse Radiation (lower curve) as a function of time series (May 1, 1995 until Feb. 5, 1998)

The Intensity some time indicated drops down (in both curves) due to, sky cloud cover or dusty days, during November and December every year, as shown in figure (1). The global solar radiation measurements are relatively high, compared with diffuse solar radiation. Global solar radiation is relatively high too, compared with other places, having nearly similar latitude (φ) to Kuwait. See for example, Alnaser [8], Al-hussainy [10] and Musa et al. [11]. Monthly average daily measurements during three years (1985-1987) for global , diffuse, Ultraviolet, and infrared solar radiation in Kuwait were gives by Alaruri S. D. ,et al. [12]. He found empirical regression models for the weather data during that period of time.

The studies of the level of the atmospheric pollution over Kuwait are given in this work. The daily variations of the ratio of diffuse radiation to global radiation (D/G) was calculated, and the results are presented in Figure (2). This ratio is a good indication of level of pollution. The data cover the period from May 1,1995, until Feb. 5,1998. This ratio decreases from year 1995 to the year 1997, by about 0.05%. This means that there is a decrease of the diffuse

radiation intensity. This is an indication of lower pollution found during 1997, when compared with the 1995, 1996.

As shown in the figure, there are peaks corresponding to the days February 25, April 15, July 30, during the year 1996, February 10, Dec. 20, during the year 1997, and January 10 during year 1998. These peaks during these days maybe due to a high dust storms or cloud cover around the area of measurements in our site (Faculty of Technological Studies, Kuwait).

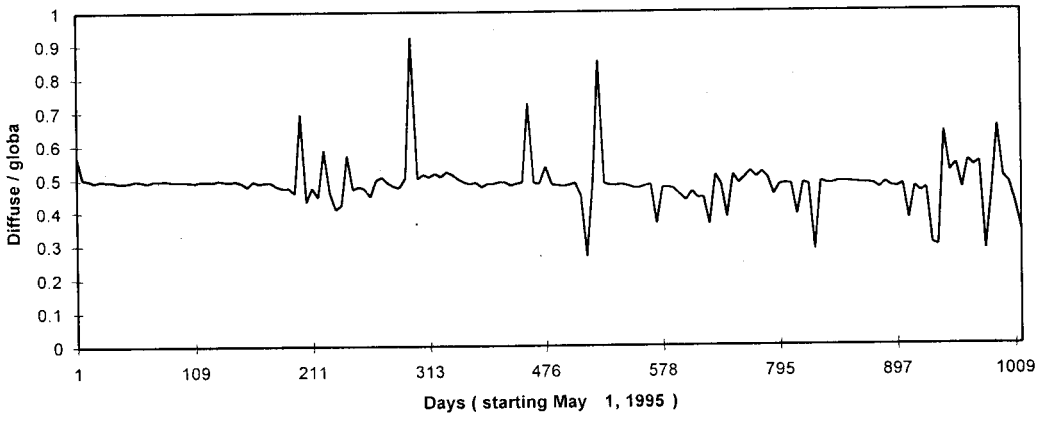

Figure (2) Diffuse to global radiation ratio as a function of time series (1015 days starting of May 1, 1995)

Ultraviolet Radiation:

The measurements of near ultraviolet radiation (315-380 nm), starting May on 1, 1995, Until Feb 5, 1998 were collected and studied. The solar Ultraviolet Intensity in (watts/m^2) is presented in figure (3), as a function of the time interval. The sky cloud cover has the same effects on this radiation as it has on Global and diffuse solar radiation. The intensity of the ultraviolet radiation was found higher during all summers .In summer 1997 the maximum is lower than that of 1995 and 1996. This mean that the absorption of the ultraviolet radiation was high during 1997, compared with the other years (1995, 1996). Figure (3) shows that there are gradual decrease of solar Ultraviolet radiation over Kuwait during this period of time. The same results of gradual decreasie of the measured solar ultraviolet region (295-385 nm) over Bahrain during the years 1985 until 1989 were obtained by som A. K., [13]. Thes results {by Some A. K.} are in good agreement with the results given in figure (3) in this work.

Anita *et al.* [14] shows that the near solar ultraviolet region (315-380 nm) is not strongly affected by Ozone, if compared with other ultraviolet wavelength regions. Then according to our measurements of ultraviolet radiation in this region (315-380 nm), a poor absorption in the Ozonosphere were observed.

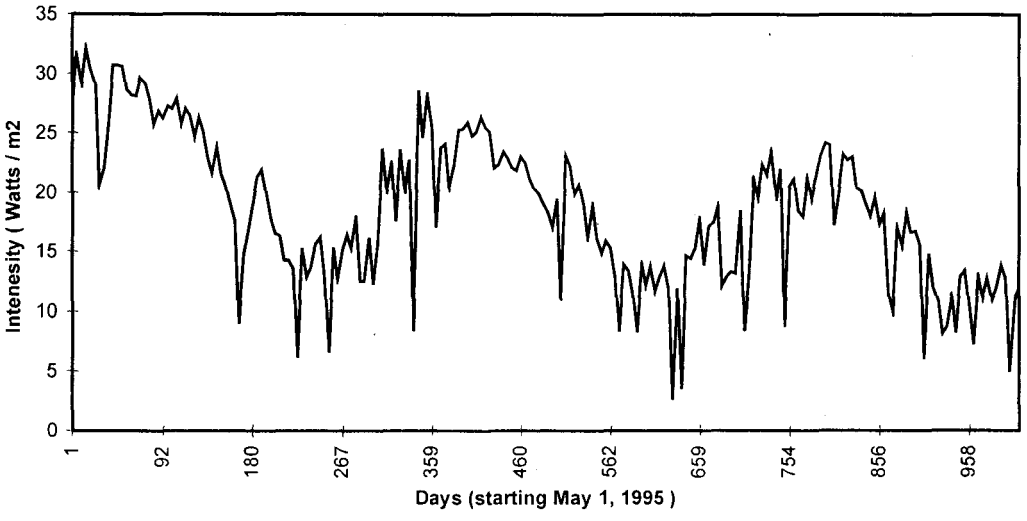

Figure (3), The recorded data of near ultraviolet Intensity as a function of time series (1015 days starting May 1, 1995)

The relation between the solar Ultraviolet and global radiation:

From the measured data of Global and Ultraviolet solar radiation, we can study the overcast skies and sandstorms in Kuwait. The ratio of the ultraviolet and global radiation (UV/G) is so low, during April and May 1996, April and May 1997, compared with other measured data of our period of time. In general, the ratio of (UV/G) is turned lower, due to the sandstorms in the Kuwaiti's atmosphere.

We forward the following linear regression relation which was deduced from the recorded data of Ultraviolet (UV) and global radiation (G) was given as:

$$UV = a_1 + a_2 * G$$

The values of a_1 and a_2 for Kuwait were give as: a_1 =0.0077, a_2 =0.0247 . For a comparison of the values of a_1 and a_2 at Cairo, Egypt during the years 1987, 1988 were given as: a_1 = 0.0113, a_2 = 0.044 , these values were given from the data collected by El-Hussainy [10]

This data of ultraviolet radiation showing that there's no difference between estimated and measured values during clear and shiny days in Kuwaiti's atmosphere. But the estimated daily values of Global and Ultraviolet solar radiation were higher than that actually measured by about 50%, during dusty and sandstorm days. This drop of measurements are due to the sudden changes in the atmospheric parameters during dusty days, and suspended particles in the atmosphere. Al-Aruri et al. [9] found that, during dusty days, the measurements are lower by 44% in Kuwaiti's atmosphere for the year 1985. This means that the atmosphere transparency during 1985 was higher than that in 1995, 1996 and 1997 in Kuwait. For comparison, The transparency over Qena / Egypt (has nearly the same Kuwaiti's latitude) were calculated from global and diffuse radiation, by El-Shazly et al. [15].

Ground Albedo:

The ground Albedo (ρ), is a good indication of ground cover and its transfer property. Diffuse and global solar radiation's were used for ground Albedo calculation. The nature of the reflected energy strongly depends upon the surface properties. The albedo of the atmosphere is the diffuse component reflected back to space, it depends on two terms, one represents the Albedo of Rayleight atmosphere and the other are the Aerosols, Iqbal, [16]. The ground Albedo is controlled mainly by the surface temperature, Essa [17]. The incoming and outgoing radiation in a certain point (our site) are in equilibrium. According to the data studied, there is inverse relation between ground Albedo values and the surface temperature growth, i.e. for low surface temperature, there were higher ground Albedo values, and vice versa, As shown in figure (4).

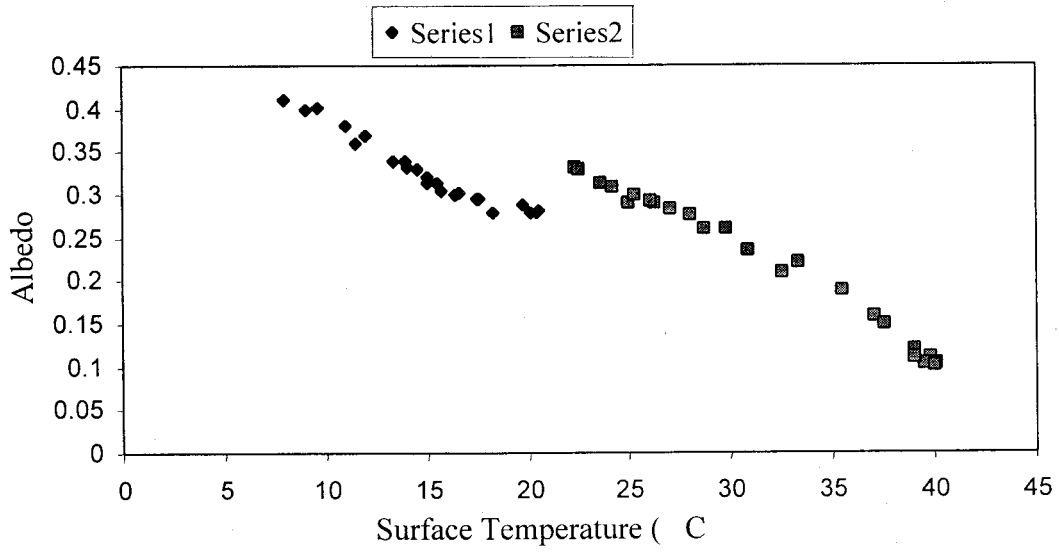

Figure (4), The ground Albedo data as a function of surface temperature for two days , March 21,1997 (Series 1) and September 21,1997 (Series 2).

The ground Albedo as a function of surface temperature was studied for about 20 days during 1996 and 1997. All studied days were shiny and clean days. In figure (4) the data analysis of two days (March 21, and September 21, 1997) For example, were given. The surface temperature at March 21, 1997 ranged between 8.1 °C and 20.5 °C, while at September 21, 1997 ranged between 22.3 °C and 40.1 °C.

The maximum values of temperature were given nearly around the midday (13 GMT), for the examined days. The inverse relation between ground Albedo and surface Temperature is shown in this figure. This inverse relation appeared too, for the studied days during1996 and 1997. This means that, there is a negative slope in the relation between ground Albedo and surface ground temperature.

CONCLUSIONS

The data for six spectral bands of different wavelength of solar radiation were measured locally (in Kuwait) during nearly three years, starting on May 1, 1995 until February 5, 1998. Global and diffuse solar radiation were measured too, during the same period of time. This data was used for calculations and analysis of the Kuwait's atmospheric properties.

The effects of seasonal and annual variation of global, diffuse and ultraviolet radiation were reported, as well as, cloud sky cover days, and dusty days for this period of time (May 1, 1995 to February 5,1988). The seasonal and annual variations have the same effects on the intensity of global and diffuse solar radiation.

The measurements of (D/G), ratios were given points out to a lower level of pollution during 1997 compared with the years 1995, 1996, by about 0.05% of the measured ratio. This means that there is a decrease of the diffuse radiation intensity during 1997. That is a good indication of the lower pollution found during 1997, if compared with the results that were given during the years 1995 and 1996.

Daily maximum value of ultraviolet radiation Intensity, which was measured during the summer 1997, is lower than, that measured values of the ultraviolet solar radiation during the years 1995 and 1996. This means that the level of pollution was slowly decreased during the year 1997.

These results of gradual decreases of solar ultraviolet radiation with time were recorded over Bahrain during the years 1985 to 1989 by Som A. K.,[13]. The results were obtained from our data of solar ultraviolet radiation is of good agreement with these given by (D/G) measurements.

The linear regression relation between the global (G) and ultraviolet (UV) solar radiation was given in the form:
UV = 0.0077 + 0.0247*G.

During the sandstorms and the cloud cover days in Kuwaiti's atmosphere, shows that the difference between the measured and estimated values of ultraviolet radiation was given about 50%. But the data of ultraviolet radiation showed that there's no difference between estimated and measured values during shiny days of Kuwaiti's atmosphere.

The ground Albedo was studied as a function of surface temperature. The inverse relation between ground Albedo and surface Temperature was obtained. This inverse relation means that there's a negative slope in the relation between ground Albedo and the ground temperature.

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