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Study of the Relative Change of Reflected Radiation in the City of Basra

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Abstract

Studying the subject of the study Studying the study of inverse change in the city of Basra "The study came to clarify the concept and characteristics of solar radiation and then reveal the factors affecting radiation in the study of the characteristics of the study of solar radiation, radiation angles to the surface of the earth, theoretical and actual brightness, then a beautiful location and water vapor pressure to reach To know the variation of the areas of reflected radiation and its relative change in the city of Basra and for the period (1988-2020). The study reached a number of results, including:

The study revealed that the highest values of total solar radiation were recorded in the months (May, June, July, August) as they amounted to (648.52, 697.2, 709.59, 673.94) megajoules / m2 day in Basra station.

The lowest values of the reflected radiation at the Basra station were during the months of (June, July and August), as its values were (147.0, 151.9, 148.8) megajoules/m2 day at the Basra station.

The study found that the values of relative change varied during the study period in Basra station, as it reached its highest value in August (9.05), while the lowest value was recorded in April (7.70), and in May it reached (7.75) for Basra station.

Keywords:

Introduction

Climate is still affecting human life in terms of its geographical distribution and economic and social activity, and climate affects agriculture, industry, soil, transport, city planning, ..etc. Hence, its relationship with other sciences emerged, which increased interest in climate studies, as man discovered energy and then Using it would enhance his knowledge, expand his perceptions, and increase his control over nature, which would increase human capabilities to discover new sources of energy and raise the level of his use of ancient and modern sources. Seeking to know the reversed radiation and its relative change in the city of Basra is very important in climate studies, and it is also considered a basis in determining the course of the climate in the city of Basra by tracing its paths in the past and building predictions for it in the future in order to know the amount of change in its general direction during the period studied. Thus, we can imagine the amount of changes taking place in the environment, which contributed to drawing the path of the reflected radiation and its impact on the elements of the climate, and that the data of the net reflected radiation in the city of Basra is almost rare, as the Iraqi meteorological stations lack such data, so the study was relied on models Mathematical

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models to extract the net reflected radiation, which are models that took a wide range of application, which were adopted by the International Meteorological Organization and the Organization (F.A.O), by relying on climate variables, some of which are available in the Iraqi climate stations, while others are lacking, which forced the researcher to use special mathematical methods to extract them.

Study Problem

The study problem is the first step in scientific research and must be carefully defined. Reaching half of the solution, so the problem of the study revolves around the following question:

What is the nature of the values of relative change of the reflected radiation in the city of Basra?

Study hypothesis

The study hypothesis is a conclusion that the researcher reaches and adheres to temporarily by setting a number of hypotheses that serve as a pre estimation of initial solutions whose validity is not proven, that is, subject to rejection or acceptance. It is a general law that can be referred to in the interpretation of all related phenomena. The hypothesis of the research is as follows: The nature of the values of relative change of the reflected radiation varies in the city of Basra.

Study Objective

The study aims to study the relative change of the reflected radiation in the city of Basra and analyze its general trend during the period (1988-2020) for the Basra station by studying the trend of its monthly and annual values, as well as predicting future values, in addition to highlighting the role of climatic factors affecting the values of Reverse radiation, and analysis of its spatial and temporal variation in the city of Basra.

The Importance of The Study

The importance of our study of the direction of the reversed radiation and its relative change in the city of Basra is because it is one of the important climatic issues that did not receive its share of attention from the climatologists. On the seriousness of the changes occurring in the path of reverse radiation in the city of Basra, as the decrease in its values in the city of Basra makes it an indication of the extent of climatic changes in the city of Basra, and what it is exposed to from the processes of attenuation carried out by the components of the terrestrial atmosphere, which affect its values as a result of what the environment is suffering from now of deterioration and pollution of all kinds, as well as the lack of awareness of the degree of danger in contact with it. Hence the importance of this study.

Boundaries of The Study Area

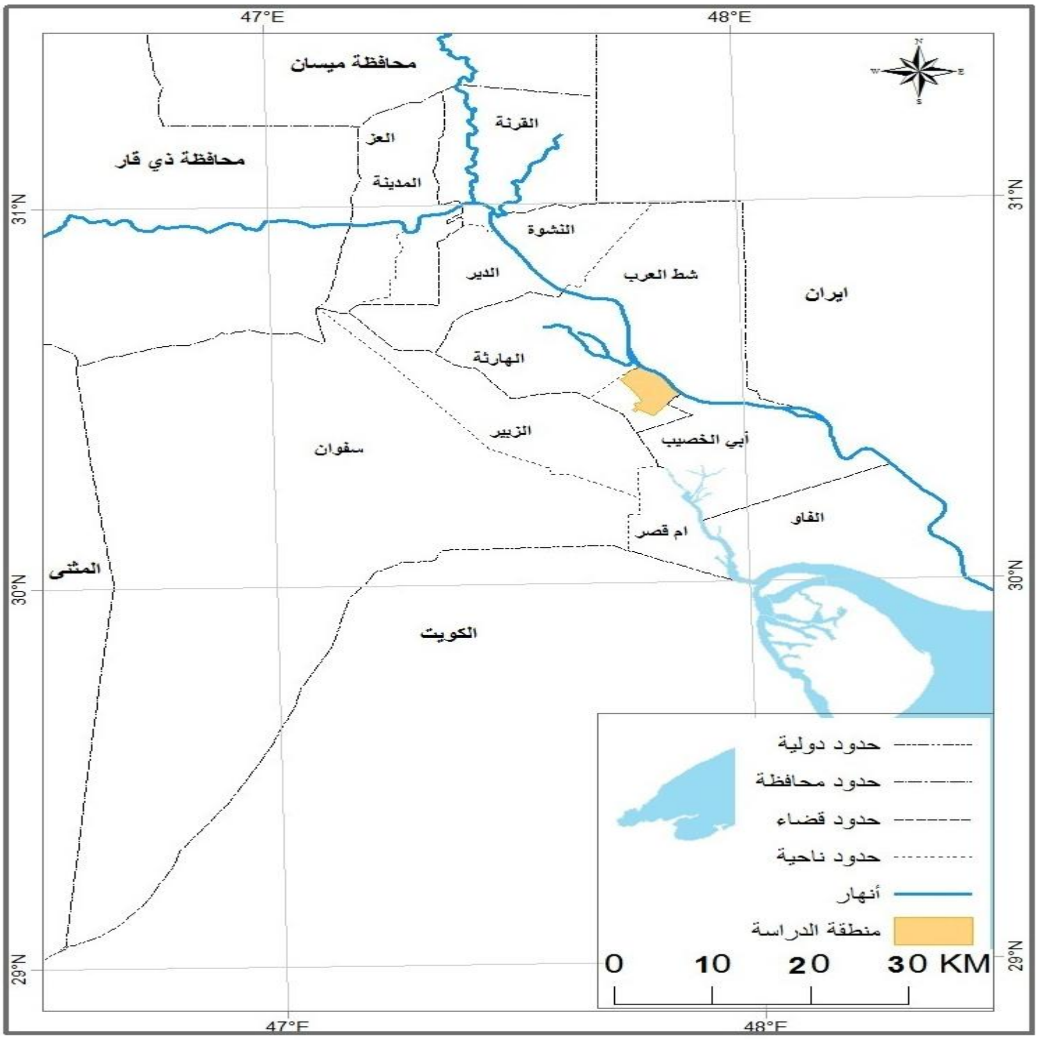
1- The spatial boundaries

The spatial dimension of the study is represented by the location of the city of Basra in Iraq and the administrative boundaries of the city according to the municipal units, as the city of Basra is located in the far south of Iraq, which is in the middle of the (4) districts of Basra Governorate, as it is bordered from the north by Al-Hartha district. Affiliated to the Basra district, and it is bordered to the south and southeast by the Abu al-Khasib district, while it is bordered to the east by the Shatt al-Arab and the Shatt al-Arab district, and it is bordered to the west and southwest by the Shatt al-Basra and the al-Zubayr district. As for the astronomical location of the study area, it is the focus of research in this field, and the aim is to limit the study area on the one hand and determine the nature of its climate on the other hand. east. Thus, its total area is 210 km2, or 1.1% of the area of Basra Governorate, which is 19070 km2. The (Basra) station was chosen.

2- Temporal boundaries

The temporal boundaries were represented for the period (1988_2020), which is around (33) years during which the values of the monthly and annual rates of reflected radiation were recorded at the Basra station. The study relied on data and information from the International Meteorological Organization and (F.A.O.).

Map (1) The location map of the study area



Source: Republic of Iraq, Ministry of Agriculture, based on the General Authority for Survey, topographic map (1:100000) for the year 1992 AD, and the program (ArcMap 10.4.1).

Reverse Radiation in The Study Area

It is defined as the transmission and spread of non-embodied energy, as is the case in thermal, light and electromagnetic energy. The inverse radiation differs from the solar radiation, as the inverse radiation is invisible rays with long waves, and is characterized by continuity throughout the day (day and night), while the solar radiation begins with sunrise and reaches its maximum in the afternoon (noon). And quantitative methods depend on measurement and analysis, which provides the researcher with an accurate objective description and clarifies the relationships away from personal factors, and it also uses a set of foundations and certain rules to obtain data and information. Reverse radiation is defined as the energy emitted from a medium by the influence of its temperature, i.e. the emission of thermal radiation is governed by the temperature of the radiating body, which is also related to the nature of the surface), and since the surface of the earth acts as a gray radioactive body, meaning that it does not absorb all the energy falling on it Therefore, the earth's surface radiates as a gray body also at a temperature of (15°C), and the higher the temperature, the greater the body's ability to emit radiation (2). At the same time, the Earth's surface works to respond to the solar rays that reach it into space by the effect of reflected rays known as the albedo. On this basis, the spectral radiation of the Earth's surface is divided into two parts(3): 1- Thermal radiation

it is the one that represents the amount of radiation emitted from the surface Earth's thermal infrared field, which is climatically termed inverse radiation, and sensible heat flux, which is the focus of our study.

3- Spectral radiation

Non-thermal reflected or reflected from the surface of the earth in the visible and near infrared range, which is represented by the albedo, which is considered a diurnal phenomenon and is the opposite of continuous reflected radiation. The reflected radiation is the flow of energy and has great importance in the field of climate; This is because it is the main and direct source of heating the atmosphere and not solar radiation, and because the air is not heated from direct solar radiation because the air is unable to absorb short-wave radiation, while the air is heated from reverse radiation (4).

Factors affecting the values of reflected radiation in the study area

There are several factors that affect the values of reflected radiation in the study area, including:

1- Solar radiation

The rays are emitted with high intensity and are in the form of electromagnetic waves, the longest of which ranges from very short waves such as gamma rays and X-rays to long waves such as radio waves, and includes visible and invisible radiation. That is, light and thermal energy on Earth and various other planets, and that solar radiation contributes (97, 99%) of the energy received on the surface of the Earth through the atmosphere, as the contribution of other energy sources is about (0.03%) only (5) and the amount varies What the atmosphere absorbs from solar radiation, according to the thickness of the air layer that the rays penetrate when it is vertical or inclined to what the air contains of gases, dust, clouds and other suspended materials (6). Where the absorption process depends on the wavelength of solar radiation, as the most important elements that carry out this process are ozone (O_3) and carbon dioxide (CO_2), as well as water vapor (H_2O), dust and other suspended materials (7). As for the oxygen gas O_2 and nitrogen N_2, which constitute 99% of the components of the atmosphere. They allow solar radiation to pass through without absorbing anything from it. Therefore, they are considered to have a high permeability to solar radiation. While carbon dioxide gas (CO_2), which is concentrated in the lower layer of the atmosphere (troposphere) due to its weight on the one hand and its association with its sources on the surface of the earth on the other hand, its rate is about 0.03% (8).

Table (1): Absorption percentages of some atmospheric components of solar radiation reaching the surface

The Source	**Percentage**
Water vapor	50-65%
Carbon dioxide	20%
Residual gases and impurities	15-30%

Source: Ahmed Ahmed Al-Sheikh, Meteorology, Mansoura University, 2004, p. 54.

The amount of diffused energy of solar radiation depends on the size of the particles, which is inversely proportional to the fourth power of the radiation wavelength, and based on that, selective diffusion occurs, which is known as Rayleigh Scattering. Its diameter is about (0.01) microns of the radiation wavelength. And the amount reflected by the clouds over any part of the earth’s surface is not related to the capacity of their cover only, but rather to the amount of their thickness, type, and degree of water saturation. Altocumulus and Altocumulus. Cirrus clouds reflect about (20%) of the amount of solar radiation. Based on the foregoing, the percentage of cloud reflection of solar radiation in general is estimated at about (23%) of the total solar energy destined for the Earth's surface. At the same time, all components of the atmosphere reflect about (39%) of the total solar radiation (9). Table (2) indicates that the amount of solar radiation varies temporally and spatially at the station of the study area, according to the difference in the angle of incidence of the sun's rays, the length of daylight hours, and the clearness of the atmosphere. As the values of solar radiation begin to increase gradually, starting from the month of (April) and reach (547.8) (MJ / m2 day) at the Basra station. This is due to the apparent movement of the sun towards the Tropic of Cancer and the large angle of incidence of solar radiation as seen in Table (2). The apparent rays of the sun move towards the equatorial latitude and fall vertically on (March 21), as the angles of incidence of solar radiation increase with a gradual increase in radiation values. The solar radiation reached (468.72) (Megajoules / m2 day) at the Basra station, and after (March 21), the solar radiation values increase because they are perpendicular to the equator and advance towards the northern half of the study area. As a consequence, an increase in the amounts of solar radiation received, as the highest values were recorded in the months (May, June, July, and August) as they reached (648.52, 697.2, 709.59, 673.94) (megajoules / m2 day) in the Basra station, respectively. The values recorded a relative increase in the stations due to the sun's rays perpendicular to the Tropic of Cancer on (June 21), which indicates a significant increase in the angle of elevation of the sun and the length of daylight hours, in addition to the absence or scarcity of clouds. Note Table (2). The stations of the study area still record a decrease in the values of solar radiation after the month of September, and it begins with a gradual decrease until it reaches its lowest decrease in the month of (December) and it records (281.79) (MJ / m2 day) in the Basra station, and the values recorded a relatively low In the stations, this decrease is due to the perpendicularity of the sun's rays over the orbit of Capricorn and its distance from the study area on (December 21) on the one hand, and the small angle of the sun's rays falling and the short hours of the day, as well as the increase in cloudiness on the other hand. From the aforementioned, it is noted that the formulas for calculating the solar and inverse radiation need data that are not available in the study area, so the researcher will adopt the following formula in calculating the solar and inverse radiation. Several mathematical formulas have been developed for his calculation by researchers specialized in the field of solar radiation, and they are approved by the Commission The International Meteorological Organization (FAO), where these statistical methods depend in their calculation on the multiple climatic data, whose data are available in meteorological stations, as well as their accuracy in extracting results. Among the mathematical formulas for calculating solar radiation, (10) was relied upon: the quadratic equation, from which the Prescott and Ankstrom equation was derived, as Odo developed an equation that links global solar radiation with daily information, and its formula is as follows (11):

$Kt = 0{,}053 + 1{,}280\ (sr)\ 0{,}283\ (sr2)$

Where: - Kt = the percentage of the inclination of the solar radiation in the sky. Sr = relative sunlight.

The IQBAI equation-12: This equation works to link the scattered radiation with the ratio of hours of solar brightness and its formula is as follows (12):

$Hd = 0.791 - 0.635(n/N)$ $Hd/H = 0.163\ 0.478(n/N) - 0.655\ (n/N2)$ where :- Hd = scattered or diffuse solar radiation. H = the amount of total solar radiation outside the atmosphere. n = actual brightness hours. N = theoretical brightness hours.

Table (2) Monthly averages of total solar radiation quantities and solar radiation values Ra (megajoules / m2 day) for Basra station for the period (1988-2020) AD.

Months	Monthly rates of total solar radiation	Solar radiation values (Ra)
January	300.39	20.9
February	354.2	25.7
March	468.72	31.4
April	547.8	36.7
May	648.52	40.0
June	697.2	41.2
July	709.59	40.6
August	673.94	38.0
September	572.1	33.3
October	306.9	27.5
November	331.8	22.6
December	281.79	19.7
annual rate	491.07	31.41

Source: from the researcher's work, based on: Richard G. Allen, Luis S. Pereira, Dirk Roes, Martin Smith, Gropevapatrans piration, f.A.O. Irrigation and Drainage, No.56, Rome.

The angle of incidence of radiation to the earth's surface

When the sun is above and with the head in a certain area, that region will receive the maximum energy of solar radiation, while the sun is inclined from the earth at an angle of (23.5) and this The region receives less energy from solar radiation estimated at (8%). It can be noted that the radiation reflection coefficient in the temperate and cold regions is greater than that of the tropics, and it appears from Table (3), that up to a latitude (35°), the energy absorbed by the surface of the Earth in addition to the atmosphere becomes more than that which is radiated to space, for this we find On the contrary, there is a surplus of thermal energy at latitude (35-90°), as the radiated energy to outer space is greater than the absorbed energy, and this is the reason why the amount of radiation received per unit area in the lower latitudes is more than it is in the upper latitudes. And it is more in the summer than in the winter, and at noon of the day it is greater than it is at other times of the day, and thus that angle determines the amount of lost (reflected) rays from the surface of the earth on the basis of the amount of solar radiation arriving and the amount of acquired solar radiation (31).

Table (3) The relationship between the coefficient of reflection of solar radiation and the degree of latitude.

the degree of latitude	80	70	60	50	40	30	20	10	0
	90	80	70	60	50	40	30	20	10
reflection coefficient	61	46	24	14	12	10	10	9	8

Source: Noman Shehadeh, Climate Science, Dar Al-Safaa for Publishing and Distribution, first edition, 2009, pg. 56, and that the astronomical location of the study area has a clear impact on the variation in the angle of incidence of sunlight at the station of the study area spatially and temporally, and according to its astronomical location, on the day (March 21) When the sun is perpendicular to the equatorial circle, the angles of incidence of solar radiation take a gradual rise in line with that movement. Table (4) shows that the angle of incidence of the rays varies for the Basra station. Solar radiation throughout the study area until it reaches its maximum on June 21 (summer solstice) in accordance with the apparent movement of the sun towards the Tropic of Cancer, so the angle reaches)82° 29) at the Basra station, after that the angles of incidence of radiation The solar system begins to decrease starting from the month of (July), as the sun continues its apparent movement gradually towards the equatorial circle, and on the day

(21 September) the sun’s rays once again perpendicular to the equatorial circle, so the angles of incidence of the rays reached (29 ° 63) at the station of Basra, this It is noted that the values of the angles of incidence of solar radiation in the month of September are higher than their values in the month of March. On (21 December) the winter solstice, that is, when the sun's rays perpendicular to the orbit of Capricorn reached (36° 29) at the station of Basra. Where the apparent movement of the sun towards the southern hemisphere results in the inclination of the sun's rays in the study area, and then the decrease in the amount of terrestrial radiation emanating from the surface of the earth during that period and through its effect on the amount of solar radiation reaching that surface.

Table (4) Monthly average angles of incidence of solar radiation (degrees) in the study area

latitude	Height (m)
31° 30	2,40
Months	Monthly average angles of incidence of solar radiation
January	46° 29
February	57° 29
March	69° 29
April	78° 29
May	82° 29
June	80° 29
July	73° 29
August	63° 29
September	51° 29
October	40° 29
November	36° 29
December	46° 29

Source: From the researcher's work, based on: Richard G. Allen, Luis S.Pereira, Dirk Roes, Martin Smith, Gropevapatrans piration, f.A.O. Irrigation and Drainage, No.56, Rome.

Hours of theoretical and actual brightness

Although the reflected radiation is characterized by its continuity throughout the day, the length of the day has a clear effect in determining the amount of radiation, due to its decisive and significant role in determining the amount of incoming solar radiation. to the surface of the earth, since it is known that the longer the length of the day, the greater the amount of rays arriving during the day to a certain area of the surface of the earth, and with it the amount of rays returning from the surface of the earth, and this becomes clear when tracking the daily course of solar radiation and comparing it with the daily course of reflected radiation. As we find that despite the continuation of the reverse radiation throughout the day (i.e. the process of energy loss from the Earth’s surface is continuous during daylight hours), it begins to rise gradually with sunrise and the start of the process of acquiring solar radiation carried out by the Earth’s surface as the lost energy is compensated for direct solar energy, and reaches its maximum in the afternoon (approximately an hour or two at noon), as this is due to the fact that the earth continues to maintain its temperature for a period of time, after the sun crosses at the time of the zenith, and in contrast to the solar radiation that begins to gradually decline When the noon time passes directly, then its amount begins to decrease until before sunrise of the other day, which leads as a result to a decrease in the earth's surface temperature (13). It is clear from the analysis of table (5) that there is a variation in the monthly averages of the theoretical hours of brightness in the study area, and this is due to the apparent movement of the sun, as after the transition of the sun and its perpendicularity to the equator on the day (March 12), the gradual rise of the hours of brightness of both types begins with it until it reaches the maximum Its average in the month of June was about (13.9) hours / day in Basra station. After that, the length of the day increases whenever we come to the northern stations of the study area, and this is due to the apparent movement of the sun, where the monthly averages of the length of the day gradually decrease after the month of June, so they perpendicular to the equator again on the day (21 September), as the length of the day reaches during this The month is about (13.3) hours / day at the Basra station, after which it continues to decrease also until it reaches its lowest rate in December, and that is due to the sun's rays perpendicular to the orbit of Capricorn on the day (21) of December, reaching (9.6) hour/day at Basra station.

Table (5) The monthly and annual averages of the theoretical and actual hours of brightness (hours/day) at the Basra station.

Station of Basra	January	February	March	April	May	June	July	August	September	October	November	December	Annual rate
theoretical brightness	9.9	10.7	11.8	12.9	12.9	13.9	14.4	14.1	13.3	12.2	11.1	9.6	12.2
actual brightness	6.3	7.4	8.1	8.3	9.7	11.3	11.3	11.1	10.3	8.8	7.4	6.5	8.8

Source: Republic of Iraq, Ministry of Transport, General Authority of Meteorology and Seismic Monitoring, Water and Agricultural Department, unpublished data, year 2021.

As for the hours of actual brightness, table (5) shows a variation of the duration of the actual brightness as well as its time and place in the study area. After (March 21), the number of hours of actual brightness begins to gradually increase with the start of the apparent movement of the sun towards the northern half, reaching (8.1) this month. At the Basra station, then the number of hours of solar brightness continues to increase until it reaches its maximum height during the months (June, July, and August), as it recorded (11.3, 11.3, 11.1), hours / day, respectively, at the Basra station, and the reason for this The increase in the hours of actual brightness during the hot months of the year is due to the lack or absence of clouds in them, in addition to the fact that the angle of incidence of solar radiation is close to the vertical during these months, and it is known that the hours of actual brightness are clearly affected by various local factors, including Manifestations of condensation of all kinds and dusty phenomena. The actual hours of brightness gradually decrease, reaching in the month of September to (10.3) hours / day at the Basra station, due to the sun's rays perpendicular to the equatorial circle on September 22, and the rates of brightness hours continue to decrease to reach their lowest levels in the months of December and January, as It reaches (6.5, 6.3) hours/day at Basra station, respectively. Where the reason for the decrease in the actual hours of brightness during the cold season of the year is due to the sun moving towards the Tropic of Capricorn and an increase in cloudiness as we progress from south to north, and as a result the increase in the frequency of cloudy days that have a role in affecting solar and terrestrial radiation, and then a decrease in their values in The study area during the cold season of the year.

Dust phenomena and its effect on the degree of transparency of the atmosphere

Dust is one of the main features accompanying the climate of the arid and semi-arid regions, which are characterized by the presence of climatic fluctuations that cause the rise of dust and sand and carry it to great distances. This phenomenon has a significant impact on the state of weather, climate and the environment, especially after this phenomenon began to worsen as a result of many environmental and climatic factors.

Therefore, this phenomenon in its three forms has a major role in the difference in air transparency. When this phenomenon occurs, the air transparency decreases significantly (14).

Where the concentrations of dust particles are large in the air in the layer that extends to a height of about (5) km above the ground level, and these concentrations within a certain volume of air have a major role in the variation of the value of the reflected radiation and its impact on the processes that cause its weakening and reducing its value, and therefore the more The air transparency was poor whenever there was a decrease in the value of the total reflected radiation and recording a low value, but if the air transparency was good, this means the arrival of large quantities of the total reflected radiation. Accordingly, the amount of reflected radiation and the accompanying heat production is directly proportional to the degree of transparency of the atmosphere. The purity of the atmosphere controls the amount of solar radiation during the day and the amount of reflected radiation emanating from the Earth’s surface during the night and day, which decreases as the atmosphere’s content of suspended matter (solid, liquid, or gas) increases, or one of the manifestations of solidarity and even pollutants, which works to reduce radiation values. Therefore, the value of the atmospheric purity factor varies from one place to another and according to the seasons of the year and the proportion of plankton present in the atmosphere and the cloudiness, as the gaseous envelope absorbs 7/10 of the reflected radiation while leaving a small percentage spread in space, as the degree of transparency of the atmosphere has a significant impact On the amount of reverse radiation emitted from the surface of the Earth (15), and we find this clear from the process of nocturnal radiative cooling, as it depends on the outcome of the radiation reflected from the surface of the Earth in the clear atmosphere, and it is equal to the difference between the self-radiation of the surface and the reverse radiation that is returned to the surface of the Earth and emitted from water vapor and carbon dioxide Carbon dioxide, vapor, clouds...etc., which are present in the lower traction layers, as the thermal radiation afterglow occurs during the night, and this depends on the temperature of the surface itself and the temperature of the air layer in contact with it and its levels of water vapor and other elements. It is noted that the nocturnal radiation cooling process accompanies it. The phenomenon of radiative heat inversion. The degree of transparency of the atmosphere is one of the most important factors in determining the amount of solar radiation coming to the Earth's surface and its temperature, as the clearness of the atmosphere means: its purity from dust, smoke, dirt, clouds and fog (16).

The pollutants, clouds and water vapor contained in the atmosphere have a significant and clear effect on the process of radiation absorption, dispersion and reflection. In turn, it affects the reflected radiation in the study area. Therefore, the time when the atmosphere's content of these components increases, the place will receive a smaller amount compared to the times when the atmosphere is more transparent (17). When the atmosphere permeates with fog, especially the so-called smog, which is considered one of the worst and densest types of fog, as it is not affected by sunrise, winds, or even rain, so it reduces the passage of sunlight and thus its arrival to the surface of the earth (18).

With regard to the effect of water vapor on the transparency of the air (atmosphere), water vapor in its gaseous state has a great ability to absorb solar radiation, especially infrared or long waves from it (infrared rays), and the high relative humidity in the air in large amounts has another role in the effect On the reverse radiation, when the relative humidity in the air rises, the size of most air impurities or aerosols increases as a result of their dissolution, and here their role in the spread and scattering of light appears at the same time, as the spread of visible light by impurities occurs due to the influence of large-size impurities ranging from (0 For this reason, the Haza nebula, which reduces the level of visibility as a result of the spread of light, occurs when the relative humidity in the air increases. This means that the high relative humidity has a major role in reducing the amount of reflected radiation received and mitigating its intensity as a result of exposure to the processes of absorption and diffusion. As for the effect of clouds on the transparency of the atmosphere, they have a major role in the clarity of the atmosphere, in order to reduce the values of solar radiation reaching the surface of the earth, especially in cloudy days in the winter season, as the percentage of what is wasted from it exceeds (74%) in cloudy days compared to on non-cloudy days, and it decreases to (53%) on partially cloudy days. The reason is due to the processes of absorption, diffusion, and reflection, and that these percentages vary according to the clouds' height, thickness, type, and water content (19).

Atmospheric humidity

The relative humidity in Iraq is affected by several factors, including fixed local factors such as water bodies and moving factors, represented by regional depressions that move over Iraq, causing an increase in relative humidity to increase the amounts of precipitation, and thermal depressions such as the Indian depression, the Sudanese depression, the Thermal Island, the Icelandic one, and others work to dry the air as a result High temperatures, and the action of the air heights that Iraq is exposed to, such as the tropical, Siberian and European highs, in addition to several other factors including vegetation and topography, especially the altitude factor, which has a role in determining the amount of relative humidity in the study area (20).

It appears from the analysis of Table (6) that the maximum relative humidity rates vary in the stations of the study area, so the monthly rates of maximum relative humidity generally increase as we advance from the south to the north of the study area, as the relative humidity values begin to gradually rise from the month of (October) and the recording continues High rates until the month of (April), and although it represents the period in which the highest rates of relative humidity are recorded during the year, nevertheless, these rates are considered low, and the decrease in relative humidity is what makes the cold season in Iraq very cold. Winter, for example, Iraq is affected by cold air heights accompanied by continental air masses on the edge of Central Asia, which leads to a significant drop in temperatures due to the low relative humidity of these air masses. However, the highest rates of relative humidity were recorded in the coldest months, which is (January February, March, April, November, December) in the study area, to reach (98.1%), (95.6%), (94.2%), (84.9%), and (97.2%) in Basra station, respectively.

Table (6) Monthly and annual averages of relative humidity (%) at Basra Station for the period (1988-2020).

Name of Station	January	February	March	April	May	June	July	August	September	October	November	December	Annual rate
Basra	98.1	95.6	94.2	84.9	72.4	58.7	66.1	65.6	81.9	89.3	93.6	97.2	83.1

Source: Republic of Iraq, Ministry of Transport, General Authority of Meteorology and Seismic Monitoring, Water and Agricultural Department, unpublished data, year 2021.

Then the relative humidity rates gradually decrease from the month of (May) until the month of (September). However, the lowest decrease for these values was recorded in the months of (June, July and August) and reached (58.7%) (66.1%) (65.6%) in Basra station. As this decline is due to the dominance of a dry continental and marine tropical mass during the summer, as well as a rise in temperatures with a lack of precipitation during this period, and the dominance of the seasonal India depression, which is characterized by its dry air, is matched at the same time by a decrease in the interruption of the recurrence of frontal depressions, which leads to Low rates in the study area.

Characteristics of the reflected radiation in the city of Basra

The characteristics of the reflected radiation in the study area will be analyzed to give a clear and integrated picture of it, because it has not received actual, accurate and comprehensive studies, as the reflected radiation in Iraq varies temporally and spatially, and this variation is linked to a group of several factors, including the angle of incidence Solar radiation, the duration of brightness, and the degree of clearness of the atmosphere in terms of cloudiness percentages or in terms of the extent to which they contain impurities and pollutants that work, to one degree or another, to obscure the reflected radiation and prevent it from escaping into outer space, in addition to several local factors. The unavailability of most of the measuring devices for some elements of the climate in the Iraqi meteorological stations, which led most researchers to use indirect methods (represented by mathematical equations) to calculate them and relying on multiple climatic data. Before addressing the terrestrial radiation equations, we will explain the most prominent climatic equations, whether they are for calculating solar radiation or related to it, which is an important requirement for calculating terrestrial radiation, but it is not applicable because it depends on data that is not available in the Iraqi airspace, to explain why we are heading towards mathematical models Developed by specialists in the field of solar radiation and approved by the International Meteorological Organization and the F.A.O Organization, and because of its comprehensiveness, flexibility in application and accuracy, as well as its reliance on climatic data available in meteorological stations.

Table (7) Monthly and annual rates of water vapor pressure (%) at Basra station for the period (1988-2020).

Name of Station	January	February	March	April	May	June	July	August	September	October	November	December	Annual rate
Basra	10.0	10.3	10.8	12.6	12.7	12.2	13.8	14.2	13.4	14.2	12.2	10.8	12.2

Source: Republic of Iraq, Ministry of Transport, General Authority of Meteorology and Seismic Monitoring, Water and Agricultural Department, unpublished data, year 2021.

Table (8) shows the variation in the values of the reflected radiation in the study area temporally and spatially, where the values of the reflected radiation in the month of March reach (145.7) megajoules m2 per day at the Basra station, as the apparent movement of the sun towards the equatorial latitude and its vertical fall in a day (21) (March), so the angles of incidence of the radiation increase, which results in an increase in the values of the reflected radiation as a result of the increase in the values of solar radiation during that period, and then after that the reflected radiation continues, recording high values during the period from (April) to September), and the reason for this is that The apparent movement of the sun and the large intentions of falling radiation from the sun, as it reaches its maximum height during this period, as well as the lack of clouds, which has an effective role in absorbing the reflected radiation and reducing its values in the study area, as it records its lowest values during those months, as the decrease in the values of Cloudiness and relative humidity during that period are accompanied by a rise in the inverse radiation values, meaning that the relationship between them is inverse. The net reflected radiation was calculated by the following equation (21):

Rnl = σ[(Tmax, K^4+ Tmin, K^4)/2](0,34

- 0,14√ea)[1,35 Rs/Rso -0,35]

whereas:-

RnI= net reflected radiation (MJm2. Day1) as in table (10).

σ = Stefan Boltzmann constant (1 4,90310 MJmm2. day)

Tmax,K= The maximum temperature is measured in Kelvin

Tmin.K= The minimum temperature is measured in Kelvin

Ea= Vapor pressure and its value was extracted from the following equation (9):

$$Ea = \frac{RHmean\ [e°(Tmax + e°(Tmin)]}{100}$$

The maximum amount of reflected radiation in the study area was during the months of (June, July and August), as its values reached (147.0, 151.9, 148.8) megajoules m2 per day at Basra station, then the values of reflected radiation begin after that with a gradual and slight decrease during the month of October The first, as it reached about (145.7) megajoules m2 days, at the Basra station, but what we notice regarding the understanding of the reflected radiation during this month exceeds the values during the month of March, and this is due to the fact that the period (1-23) in the month of September is still rays The sun is vertical in the northern hemisphere, so we find that the values of the angle of incidence of solar radiation in the study area are high compared to the month of March.

The rates of reflected radiation decrease in the month of October until the month of (February), as the decrease in the values of the reflected radiation during that period of the year is due to the apparent movement of the sun towards the south towards the Tropic of Capricorn, where the values of solar radiation reaching the study area and during this period are very few. Because of the low angle of incidence of solar radiation and the short duration of the day, as well as the decrease in the degree of clearness of the air as a result of the frequent frequency of cloudy days, which works to block solar radiation on the one hand and absorb reflected radiation on the other hand, this contributes to absorbing and reducing the amount of radiation reaching the surface of the study area during the cold season of the year. We also notice that the reflected radiation reaches its lowest value in the study area, in the month of (April), as it reached a value of (129.0) megajoules m2 day in the Basra station.

Table (8) Monthly and annual rates of reflected radiation (megajoules/day) at Basra station for the period (1988-2020)

Name of Station	January	February	March	April	May	June	July	August	September	October	November	December	Annual rate
Basra	139.5	134.4	145.7	129.0	139.5	147.0	151.9	148.8	144.0	145.7	141.0	142.6	142.42

Source: Republic of Iraq, Ministry of Transport, General Authority of Meteorology and Seismic Monitoring, Water and Agricultural Department, unpublished data, year 2021.

Calculation of the relative change of reflected radiation in the city of Basra

As for the relative change, it witnessed changes during the study period in Baghdad station and the variation of those changes, as it was recorded in January (8.48), while in February it was (8.11), while in March it was recorded (8.46), while in April it was (8.46). 7.70) at the Basra station. In May it reached (7.75), in June it scored (8.29), in July it scored (8.93), in August it reached (9.05), in September it scored (8.31), and in October it scored (8.31). (8.21), and in November it recorded (8.37), and in December it recorded (8.34) at Basra station, respectively, Table (9(.

Table (9) Monthly rates of relative change (%) at Basra station for the period (1988-2020 A.D).

Name of Station	January	February	March	April	May	June	July	August	September	October	November	December
Basra	8.84	11.8	8.46	7.70	7.75	8.29	8.93	9.05	8.31	8.21	8.37	8.34

Source: Republic of Iraq, Ministry of Transport, General Authority of Meteorology and Seismic Monitoring, Water and Agricultural Department, unpublished data, year 2021.

The general direction of the city of Basra:

Prediction for the future depends on the use of statistical analysis to reach clarification of the general trend, and this is what the researcher sought to apply in the city of Basra, in order to what will happen in the future to the changes that control the development of a phenomenon, as well as a statement of the relationships between the variables of the phenomenon, the subject of prediction for a future period (22).

Therefore, it will rely on the use of the general trend method in order to clarify the changes that occurred in the values of the reflected radiation in the city of Basra, in, and the trend coefficient was expressed as a percentage of the total variables in the elements of the climate, as well as for the rates of annual change according to the following equation (23):

c = annual relative rate of change* c $\frac{bi}{y} * 100$

bi = direction coefficient $\frac{\bar{x}2 - \bar{x}1}{T1 - T2} * 100$

y = arithmetic mean

(bi**))can be extracted from the following equation:

$\bar{x}1 - \bar{x}2$ =The difference between the two means

$\bar{T}1 - \bar{T}2$= The difference between the two times

It is clear from the analysis of Table (10) that there is a clear spatial variation in the values of the reflected radiation during the month of January at the Basra station, as well as the clear temporal variation during the study periods. The study had a positive trend coefficient towards a decrease in the values of the reversed radiation, as it was recorded (11.645) Dobson, but during the month of February, the Basra station recorded during the study period a positive trend coefficient towards a rise also in the values of the reversed radiation, as it was recorded (1.729) Dobson, and the month of March began to rise Gradually, it recorded high values of (7.015) Dobson.

The month of April reached (7,880) Dobson, the month of May (5,182) Dobson, and the month of June (9,659) Dobson, which was distinguished by positive values, while the months (July, August, September, October and November) recorded negative and low values, as it recorded (-1.534) (-9.619) Dobson (-9.619) (-5.823) Dobson (-9.441) Dobson (-2.265) Dobson, then it recorded an increase in December (1.615) Dobson.

Table (10) Monthly averages of the general trend in Basra station for the period (1988-2020).

Name of Station	January	February	March	April	May	June	July	August	September	October	November	December
Basra	1.615	1.729	7.015	7.880	2.747	8.052	-1.534	-9.619	-5.823	-9.441	-2.265	11.645

Source: Republic of Iraq, Ministry of Transport, General Authority of Meteorology and Seismic Monitoring, Water and Agricultural Department, unpublished data, year 2021.

Conclusions

1. The study showed that about (80%) of the solar radiation is reflected by cumulonimbus and cumulonimbus clouds. Cirrus clouds reflect about (20%) of the amount of solar radiation. Based on the foregoing, the percentage of cloud reflection of solar radiation in general is estimated at 23% of the total solar energy destined for the Earth's surface.

2. The study revealed that the highest values of total solar radiation were recorded in the months (May, June, July, and August) as they amounted to (648.52, 709.59, 673.94) (MJ/m2 day) in Basra station.

3. The study showed that on March 21, when the sun is perpendicular to the equatorial circle, the angles of incidence of solar radiation take a gradual rise in line with that movement. Basra, and the increase in the angle of incidence of solar radiation continues throughout the study area until it reaches its maximum on June 21 (summer solstice), in agreement with the apparent movement of the sun towards the Tropic of Cancer, so the angle reaches (´29 ° 82) at the station of Basra.

4. The study showed that the maximum theoretical brightness levels were recorded in the month of June, when it reached about (13.9) hours / day in the Basra station, while its lowest limit was in the months of December and January, when it reached (9.6) (9.9) hours / day in the Basra station.

5. The study showed that the maximum increase in the actual brightness rates was recorded in the months (June, July, and August), as it reached (11.3, 11.3, and 11.1), hours / day, respectively, in the Basra station, while its lowest limit was in the months of December and January, when it reached to (6.5) (6.3) hours / day, respectively, at Basra station.

6. The study showed that the highest rates of relative humidity were recorded in the coldest months, which are (January, February, March, April, Chin Thani, December) (98.1%), (95.6%), (94.2%), (84.9%), and (97.2%). %) in Basra station, while the lowest decrease of these values was recorded in the months of (June, July, August) and reached (58.7%) (66.1%) (65.6%) in Basra station.

7. The study showed that the highest rates of relative humidity were recorded in the coldest months, which are (January, February, March, April, Chin Thani, December) (98.1%), (95.6%), (94.2%), (84.9%) %), and (97.2%). %) in Basra station, while the

lowest decrease of these values was recorded in the months of (June, July, August) and reached (58.7%) (66.1%) (65.6%) in Basra station.

8. The study concluded that the values of relative change varied during the study period in Basra station, as it reached the highest value in August (9.05), while the lowest value was recorded in April (7.70), and in May it reached (7.75) for Basra station.

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