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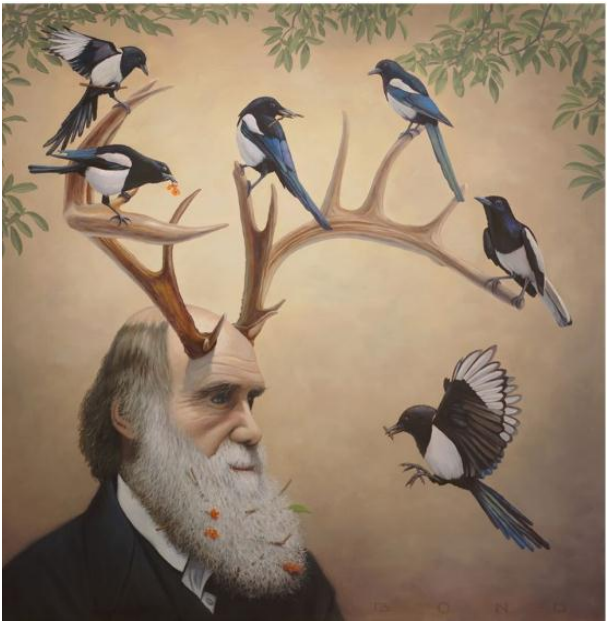

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Geographical Analysis Of Annual Thermal Ranges Trends In Iraq

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Abstract

The values of annual thermal ranges between stations of the study area witness a spatial variation in their rates and directions, reflecting the effect of the controls affecting the variation of the solar radiation distribution over the region and consequently the thermal range, as their rates ranged between (38.0) m in the Rutba station, and (42.2) m in the station Mosul, all climate stations covered in the study recorded positive trends during the academic period (1988-2017), with the exception of Al-Nukhaib Station, which took a negative direction during the period. It is also noticed that the values of the relative change coefficient (%) between the stations of the study area varied, as the parameter values ranged between (-0.47)% in Al-Nukhaib station, and (5.48)% in Al-Ramadi station, which is what The degree of change in the phenomenon during the study years reflects the effect of charting its course during the study period, and the trend coefficient values varied between stations of the study area, as the coefficient values ranged between (-0.0083) in the Al-Nukhaib station, and (0.1054) in the Ramadi station Also.

Análisis Geográfico De Las Tendencias De Los Rangos Térmicos Anuales En Iraq

Resumen
Los valores de los rangos térmicos anuales entre las estaciones del área de estudio son testigos de una variación espacial en sus tasas y direcciones, lo que refleja el efecto de los controles que afectan la variación de la distribución de radiación solar en la región y, en consecuencia, el rango térmico, ya que sus tasas oscilaron entre (38.0) m en la estación Rutba, y (42.2) m en la estación Mosul, todas las estaciones climáticas cubiertas en el estudio registraron tendencias positivas durante el período académico (1988-2017), con la excepción de la estación Al-Nukhaib, que tomó Una dirección negativa durante el período. También se observa que los valores del coeficiente de cambio relativo (%) entre las estaciones del área de estudio variaron, ya que los valores de los parámetros variaron entre (-0.47)% en la estación Al-Nukhaib y (5.48)% en Al-Ramadi estación, que es lo que El grado de cambio en el fenómeno durante los años de estudio refleja el efecto de trazar su curso durante el período de estudio, y los valores del coeficiente de tendencia variaron entre las estaciones del área de estudio, ya que los valores del coeficiente oscilaron entre (-0.0083) en la estación Al-Nukhaib, y (0.1054) en la estación Ramadi También.

Introduction:

The annual thermal range is defined as the difference between the temperature of the warmest months and the coldest temperature in a region (1). Knowing the characteristics and distribution of the thermal range and its values and determining its directions are important matters in geographical studies, as its values, characteristics and trends vary due to A number of factors affecting it, foremost of which are the astronomical location of the region, and the proximity or distance from the water bodies that determine the degree of the continental region, and the difference in the length of the day depending on the location of the circles and the different angles of solar radiation fall, in addition to the variation of cloud coverage and frequency of phenomena The dust that the study area is exposed to, and it was done in this study To study the extraction of annual thermal ranges based on the data of climatic stations available from the General Authority for Meteorology and Seismic Monitoring, then extract and determine their direction using the program (spss.24) depending on the least squares

method.

The first topic (theoretical framework for the research)

1- The problem of the study: The problem of the study is the scientific question that exists in the mind of the researcher and tries to obtain adequate answers about it through research mechanisms, and it can be formulated with the following:

What is the nature of trends in the annual thermal ranges in Iraq?

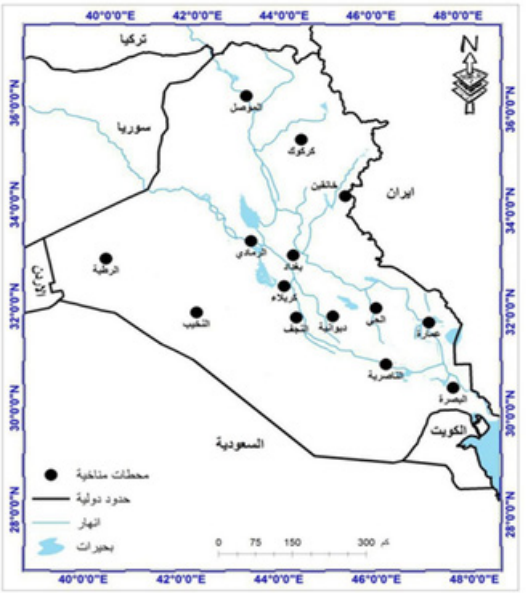
2- The study hypothesis: The study hypothesis represents preliminary answers to what the researcher is looking for in his problem, and the study hypothesis came as follows:

- The annual thermal ranges in Iraq are taking an increasing trend in the study area.

3- The objective of the study: This research aims to determine the tracks of the annual thermal ranges, and to analyze their geographical trends during a specific time period.

4- The boundaries of the study area: The spatial boundaries of the research were in the administrative borders of the Republic of Iraq, which is located in the southwest of the Asian continent, as it is bordered on the north by Turkey, on the east by Iran, on the west by Jordan, on the southeast by the Arabian Gulf, Kuwait, and on the southwest by Saudi Arabia.

, As Iraq extends astronomically between the two latitudes (37-59-5) north and south, and arc lengths (5-838-548) east (2), map No. (1).



Map (1)
Distribution of climate stations in the study area
Source: Researcher work based on the General Authority for Meteorological and Seismic Observations, Baghdad, Atlas of Iraq Climate, 2019. And Arc.Gis v10 output.

The second topic: analysis of trends in annual thermal ranges:

First: Annual thermal ranges:

The data provided in Table No. (1) indicate the variation of the values of annual thermal ranges in time and spatially in the study area, as the values of the annual thermal ranges witness a significant expansion in their values in the stations of the northern region, due to the geographical distance of the region from the nearest transverse circles of the cancer orbit, In addition to the factor of the terrain height, and its impact on the air masses associated with the pressure systems controlling Iraq during the hot and cold season of the year and the high percentage of cloudiness and days forming fog in the region, which affect the Earth's receipt of solar radiation and work to attenuate it, which is reflected in a visual way The annual variation of the thermal extents values and trends.

The table indicates the variation of the values of the ranges of the climate stations covered by the study spatially in the study area, as the amplitude of the thermal ranges decreases in the south, the Mosul station recorded the highest rate among the studied stations amounted to about (42.20) m, while the Baghdad station recorded a rate of (41.20) m In the Al-Rutba station, the average annual thermal range reached a value of about 38.00 m, and the average annual thermal range in the neighborhood station was about 39.60 m. As for the Basra / Hussein station, the rate rose slightly from the neighborhood station. It reached about (40.00) A.D., due to the seasonal variation of the effect of the waters of the Persian Gulf adjacent to the region.

We conclude from the above that the values of annual thermal ranges are spatially different in the study area, as their values decrease in direction towards the southern regions, as the northern stations witnessed the highest values, for the reasons previously mentioned, then the decreasing values in the stations go in the south, as recorded in the western region stations and The eastern region decreased in the breadth of the thermal range due to reasons related to the terrain elevation in the first region and the influence of the Iranian-Iranian highlands in the second region, as well as the influence of local factors such as the presence of marshes and swamps in the south-eastern regions, which affected Pine thermal extents values.

Table (1)

Annual thermal ranges in the study area for the period (1988-2017)

Basra / Al-Hussein	Nasiriya h	Alamara	Diwaniy a	Alba y	Najaf	Karbala	Anak eeb	Al ruth a	Alrumaid i	Baghdad	Khanaqi n	Kirkuk	Mosul	The year
38.5	38.3	38.9	38.1	37.3	40.6	39.5	39.9	35.3	37.0	39.1	37.4	37.6	38.0	1988
42.8	42.9	42.9	41.6	42.0	42.1	42.8	41.5	40.0	42.4	45.2	44.3	41.5	44.7	1989
40.5	41.2	41.1	40.2	39.6	42.3	40.4	41.6	39.3	36.8	40.9	41.5	41.2	43.3	1990
36.3	37.0	40.4	36.0	36.8	40.1	37.0	38.9	35.5	36.5	37.7	39.6	38.9	41.5	1991
40.2	40.9	40.7	40.0	39.4	41.1	41.2	39.4	39.3	39.4	41.9	40.7	39.8	42.6	1992
40.2	39.8	39.1	38.7	38.5	39.3	40.0	41.3	37.5	39.0	40.4	42.5	40.4	43.0	1993
38.5	35.6	38.3	37.0	36.4	38.0	37.4	38.8	35.8	36.9	39.2	40.2	39.5	41.2	1994
38.3	39.0	38.9	35.8	35.7	37.2	37.7	39.7	35.8	36.8	39.9	40.7	38.2	42.4	1995
38.4	38.7	37.9	37.7	37.9	38.8	38.6	42.5	37.8	36.7	40.0	40.4	38.9	40.9	1996
39.5	39.6	37.5	39.1	39.3	37.4	39.2	43.5	37.3	37.9	42.8	41.0	39.6	41.9	1997
41.3	41.4	39.5	40.3	41.3	40.7	41.5	41.6	39.4	39.3	42.0	43.0	41.8	42.5	1998
39.7	38.9	38.2	37.8	39.3	37.9	36.8	40.7	37.2	36.4	40.2	39.3	37.3	40.7	1999
41.0	42.2	41.3	41.8	42.0	42.2	41.7	41.5	40.6	40.2	43.7	42.4	42.0	44.1	2000
38.7	42.0	40.9	40.9	42.1	40.3	39.8	41.4	37.6	39.9	41.9	41.4	39.1	41.1	2001
40.5	41.3	41.2	40.2	40.9	39.7	39.3	41.8	39.4	39.7	42.1	40.6	39.2	41.3	2002
39.4	40.7	40.7	40.5	41.6	39.3	38.2	42.2	36.8	39.5	40.9	40.4	38.6	40.8	2003
41.0	41.5	41.5	40.4	40.4	41.8	40.5	44.2	36.1	40.2	41.6	42.2	39.5	42.7	2004
39.5	40.2	40.4	38.4	39.7	41.2	38.8	42.8	38.8	39.6	39.9	41.1	39.2	41.9	2005
42.5	42.8	42.2	40.4	38.6	42.3	41.7	43.5	39.8	40.5	42.2	43.4	40.6	44.6	2006
39.6	41.5	42.0	40.8	41.9	42.0	40.5	43.4	38.9	40.9	41.8	41.3	39.3	42.6	2007
43.0	43.1	43.3	42.5	42.6	42.7	42.8	45.1	42.0	43.4	44.2	43.6	41.2	46.4	2008
41.1	41.7	40.4	40.2	37.8	41.7	40.9	41.9	36.9	40.3	41.7	41.0	35.4	41.8	2009
39.1	40.4	37.8	37.4	37.9	38.9	39.5	40.0	36.9	38.9	39.7	39.1	38.1	41.7	2010
41.1	40.1	40.2	40.0	38.8	39.2	41.3	39.6	38.2	40.7	41.4	42.6	40.6	42.2	2011
41.1	41.8	42.8	38.7	41.7	40.7	41.4	39.2	39.0	41.6	42.7	42.4	41.1	41.5	2012
38.1	37.5	41.0	38.4	38.0	37.1	37.9	38.2	36.0	37.9	37.0	40.1	38.6	42.3	2013
37.6	38.1	38.0	37.5	38.6	38.7	38.7	38.9	37.6	39.4	38.6	40.4	38.0	41.4	2014
40.0	41.1	40.7	39.1	39.6	40.2	40.2	40.6	36.3	39.4	41.7	41.7	39.2	40.8	2015
40.6	41.9	40.7	40.3	40.3	41.1	40.8	40.1	36.6	38.7	41.5	43.2	43.0	40.7	2016
42.2	43.6	42.2	42.3	41.7	41.5	42.6	40.3	41.1	43.2	44.5	45.6	42.4	44.9	2017
40.0	40.5	40.4	39.4	39.6	40.2	40.0	41.1	38.0	39.3	41.2	41.4	39.7	42.2	the average

Source: Republic of Iraq, Ministry of Transport and Communications, General Authority for Weather Forecast and Seismic Monitoring, unpublished data, 2019.

Second: Annual thermal ranges trends:

The researcher here aims to determine the trends of the annual thermal ranges during the study period (2017_1988) for all climate stations covered by the study using the least squares method, in addition to extracting the annual rates and deviation coefficients and the relative change rate% for the annual thermal ranges for the climate stations covered by the study, using the SPSS program .v24).

We note from Table (2) that all climatic stations covered in the study recorded positive trends during the academic period (1988-2017), except for the Nakhib station, which took a negative direction during the period, and notes the variation of the values of the relative change factor (%) between the stations of the study area, as the coefficient values ranged between (-0.47)% in the Al-Nukhaib station, and (5.48)% in the Ramadi station, which reflects the degree of change in the thermal ranges recorded during the years of the study in the impact of charting its course during the period specified in the study, as has been The values of the trend coefficient varied between the stations of the study area, as the coefficient values ranged between (-0.0083) in the Al-Nukhaib station, and (0.1054) in The Ramadi station also, as it appears that the fluctuation of the values ranged between

(3.84) in the Mosul station and (4.89) in the Ramadi station.

Table (2)

Coefficient of deviation and direction of annual thermal ranges (m) in the study area for the period (1988-2017)

%Change rate	Direction	variance	Coefficient of fluctuation	Standard deviation	The rate	The station
1.12	0.0182	2.62	3.84	1.62	42.2	Mosul
0.98	0.0164	2.8	4.22	1.67	39.7	Kirkuk
3.67	0.0621	2.87	4.09	1.69	41.4	Khanaqin
1.85	0.0359	3.75	4.69	1.94	41.3	Baghdad
5.48	0.1054	3.7	4.89	1.92	39.3	Alrumadi
1.31	0.0231	3.13	4.66	1.77	38.0	Al rutba
-0.47	-0.0083	3.08	4.27	1.75	41.1	Alnakeeb
2.65	0.0449	2.87	4.24	1.7	40.0	Karbala
2.9	0.0552	3.61	4.8	1.9	39.6	Alhay
0.54	0.009	2.8	4.16	1.67	40.2	Najaf
2.67	0.0466	3.05	4.43	1.75	39.4	Diwaniya
2.83	0.0461	2.65	4.04	1.63	40.4	Alamara
3.55	0.0683	3.71	4.76	1.93	40.5	Nasiriyah
2.4	0.038	2.51	3.96	1.58	40.0	Basra / Al-Hussein

Source: The work of the researcher based on Table (1).

In order to clarify and analyze the variance in the directions of the thermal ranges in the study area, five climatic stations were chosen to cover the region (Mosul, Baghdad, Rutba, Al Hayy, Basra / Al Hussein), represented by the north, center, west, east and south of the study area.

1 / Mosul station:

The data provided in Table (2) and Figure (1) indicate that the annual thermal ranges in the Mosul station, which represents the north of the study area, have recorded a high trend during the study period, as a positive direction factor of (0.0182) was recorded, and the station recorded the highest annual rate For the extent between the study stations, its value was about (42.2) m, while the rate of relative change during the study years was about (1.12%), and the fluctuation of the values around its mean was about (3.84), with a standard deviation and a degree of variance (2.62_1.62).

(Respectively, and it is noted that the year (2008) has recorded the highest annual temperature range between the years of the study period with a value of (46.4) ° C) which is higher than the general average recorded The station has a period of (4.2) m, while the lowest value of the thermal range of (38.0) m was recorded in the year (1988), and it is less than the average by (4.2) m, as it is noted that (13) years of the studied period have recorded a range An annual higher than the general average for the station, and that (16) years have recorded a temperature range lower than its general average, while in the year (2011) a value of the annual thermal range equal to the general average was recorded (42.2) m.

The direct cause of the expansion of the thermal range in this region is due to the geographic location of the region, and the terrain elevation factor which is a support factor in the formation of cloud cover and thus precipitation, and the beginning of the incursion of cold air masses in the cold season of the year, and the decrease in recorded temperatures In the cold season and its moderation in the hot season, which is reflected in the large thermal range in it.

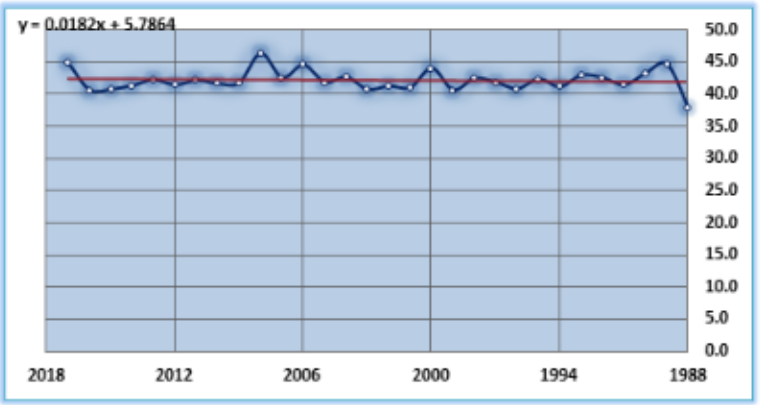


Figure (1) Direction of the annual thermal range (° C) in Mosul station for the period (1988-2017).

Source: The work of the researcher based on Table (1).

2 / Baghdad station:

It is clear from Table (2) and Figure (2) that the annual thermal ranges in the Baghdad station located within the central region of the study area have followed a positive trend during the years of the study, as it recorded a trend of value (0.0359) during the period with a positive change rate of

about 1.85 %), As the station recorded an annual rate of range of (41.3) m, which reflects the impact of the geographical location in the central region, as well as the distance factor from the effects of water bodies (the Arabian Gulf), and local factors are added to it and the effect of population crowding that It affects the thermal properties in the region and consequently its effect on the expansion of the thermal range. This has reached the fluctuation of values About its general average is about (4.69), and the scattering measures, the recorded standard deviation of the station was about (1.94), and a variation of (3.75), and the highest annual range during the study years was in the year (1989) and it reached about (45.2) m This is higher than the general average by (3.9) m, and the year (2017) recorded a high annual range with a value of about (44.5) m, while the year (2013) recorded the lowest annual range that reached (37.0) m, and the years (2016_2011) annual mean values have been recorded close to the station average rate of (41.5_41.4) m, respectively.

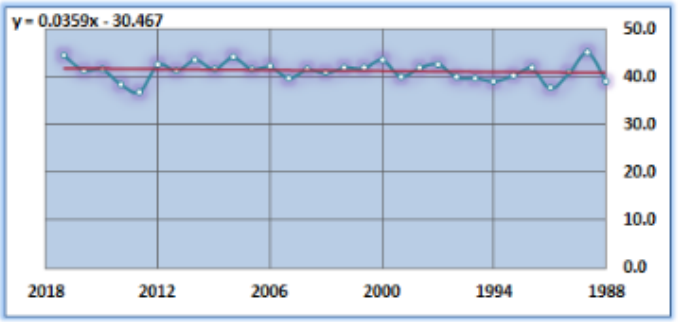


Figure (2) Trend of annual thermal range (° C) in Baghdad station for the period (1988-2017).

Source: The work of the researcher based on Table (1).

3 / Al-Rutba Station:

The data provided in Table (2) and Figure (3) of Al-Rutba station located in the western sections of the study area indicate that the annual thermal ranges in it were high during the study years (2017_1988), as the station recorded a positive trend coefficient with a value of (0.0231) With a relative positive rate of change during the period, it reached (1.31%), and it is noted that the Rutba plant has recorded the lowest annual rate of range between the weather monitoring stations studied during the period reached (38) m, which explains the influence of the climate of the region

directly on the effects of the Mediterranean, especially the highlands. Air depressions, being the forerunner of the affected areas of Iraq, and this station has been recorded by M. I hope for fluctuations in values around its mean amounted to (4.66), with a degree of variance and standard deviation whose value (1.77_3.31) during the period, as it turns out that the highest value of annual thermal ranges during the study period has reached about (42.0) m, which is higher than the value The general average for the station is (4) ° C, as recorded in the year (2017), a high annual thermal range also reached (41.1) ° C. As for the first years of the time series (1988), it witnessed recording the lowest value of the range during the period amounted to about (35.3 ° C), and It is lower than the general average value by (2.7) m, and low values for the annual ranges were (35.5), (35.8), (36.8), (36.1), (36.3) (36.6) m for the years (1991-1994-2003- 2004-2015-2016) respectively.

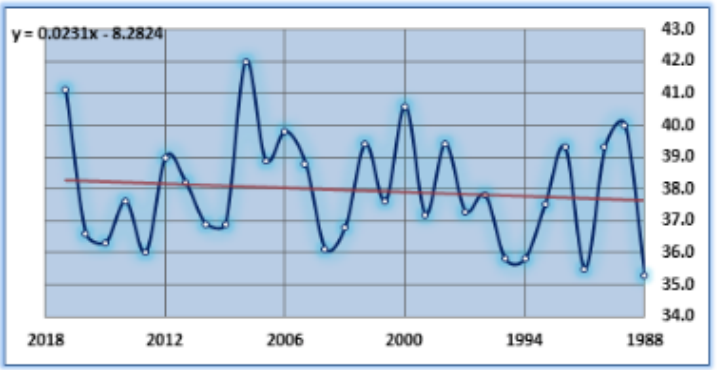


Figure (3) Trend of annual thermal range (° C) in Rutba station for the period (1988-2017).

Source: The work of the researcher based on Table (1).

4 / Neighborhood station:

It is clear from the data provided in Table (2) and Figure (4) that the neighborhood station located in the eastern parts of the study area has recorded an increasing trend of the thermal range during the study period, its positive value reached (0.0552) and the rate of relative change during the period reached its value ((2.9), as the station recorded a low annual rate compared to other stations (39.6) m, which explains the effect of the terrain nature of the surface area of the area surrounding the eastern mountainous highlands on its climate, and the value of fluctuation coefficient

around its general average has reached (4.8) and a rate of Variation and standard deviation was (1.9_3.61) during the period.

It is noticed through tracking the years of the time series of the neighborhood station that the highest recorded value of the annual thermal ranges was in the year (2008), when it reached a value of about (42.6) C, which is higher than the value of its general average by (3) C, while it was recorded in (1995)) The lowest value of the thermal range reached (35.7) m, which is lower than the value of the rate with (3.9) m, as the time series witnessed an increase and decrease in the values of the thermal ranges, as the years (2001_2000_1989) recorded relatively high values compared to the rest of the series values, as they reached about (42.1_42.0_42.0) m, respectively, and the time series also witnessed a decrease in the values of the thermal ranges in my years (1994_1991), which amounted to (36.4_36.8) m, and imposed the terrain position of the m A region and the nature of its surface itself as an effective influence in this area, as mountain heights affect the thermal properties in it, which reduces the recorded temperatures and thus low thermal difference between the hot and cold season of the year.

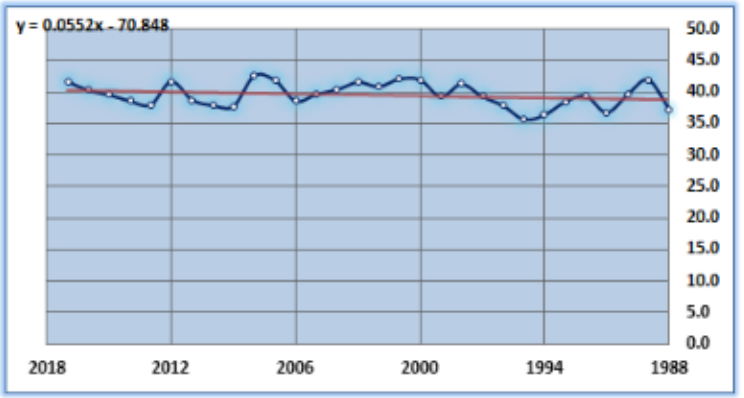


Figure (4) Direction of the annual thermal range (° C) in the Hay station for the period (1988-2017).

Source: The work of the researcher based on Table (1).

5/ Basra / Al-Hussein Station:

It is noted from the data provided in Table (2) and Figure (5) the height of the annual thermal ranges track in the Basra-Al-Hussein station during the study years, as a positive trend coefficient was recorded for the time series with a value of about (0.038) and a positive relative change of direction

It reached (2.4%), and an annual average rate of the annual thermal range reached about (40) m, while the coefficient of fluctuation of values around its general average reached (3.96). We note that the dispersion measures have recorded values amounting to (1.58) for the standard deviation and (2.51)) For variation during the school years.

It is noted on the years of the time series of Basra-Al-Hussein station, that the value of the annual thermal range has risen above its general average in the year (2008), as its value reached about (43.0) m, which is higher than its general average by (3) m, as some The years of the series recorded high values for the annual thermal ranges, which amounted to about (42.5_42.8_42.2) m respectively in the years (2006_1989_2017). As for the year (1991), it witnessed recording the lowest value of the thermal range between the years of the study period (2017_1988) amounting to (36.3) m, which is less than the general average for the station during the period by (3.7) m, and recorded low values as close to it in the years (2014_2013_1996_1995) amounted to (37.6_38.1_38.4_38.3) m.

The reason for the decrease in the value of the annual thermal range in this region is due to the nature of its geographical location, which is confined between two latitudes (31.20-29.50 °) north within the subtropical region, as the sun is in a vertical position once during the year during the hot season of the year As they are subject to the influence of the semi-orbital high pressure system (3), which hinders the growth of escalation processes and the formation of clouds, so the region has a clear sky (4), which increases the amounts of solar radiation received in it and thus increases the maximum and maximum temperatures and smallness The value of the annual run .

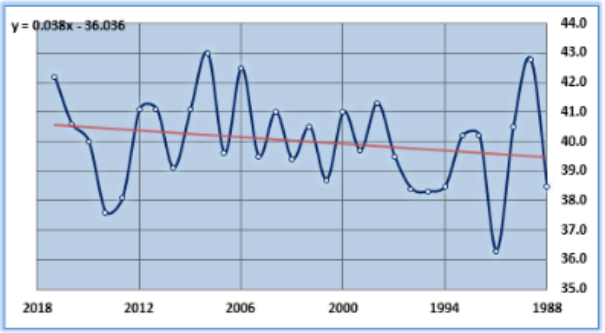


Figure (5) Trend of annual thermal range (° C) in Basra-Al-Hussein station for the period (1988-2017).

Source: The work of the researcher based on Table (1).

Conclusions:

1-Variation in the values of annual thermal ranges between the stations of the study area, a spatial variation that reflects the effect of the controls affecting the variation of the solar radiation distribution over the region and, consequently, the thermal range, as their rates ranged between (38.0) m in the Rutba station, and (42.2) m in the Mosul station .

2- All climatic stations covered in the study recorded positive trends during the academic period) 1988-2017, (as all of them took positive trends during the years of the time series, except for the Al-Nukhayb station, which took a negative direction during the period.

3- The values of the relative change coefficient (%) varied between the stations of the study area, as the coefficient values ranged between (-0.47)% in the Al-Nukhaib station, and (5.48)% in the Ramadi station, which reflects the degree of change in the phenomenon during years studying

4- The trend coefficient values varied between the stations of the study area, as the coefficient values ranged between (-0.0083) in the Nukhaib station, and (0.1054) in the Ramadi station as well.

Margins:

1- Salar Ali Khidr Al-Dazai, Iraq's Ancient and Contemporary Climate, i 1, Baghdad, 2013, p. 214.

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3- Ahmed Saeed Hadid and his colleagues, The Local Climate, University of Mosul, 1982, p. 68.

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5- Republic of Iraq, Ministry of Transport and Communications, General Authority for Meteorological and Seismic Monitoring, unpublished data, 2019.

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