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THUNDERSTORM DYNAMIC ANALYSIS BASED ON TOTAL PRECIPITATION OVER IRAQ

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Abstract

Thunderstorms occur in a type of cloud known as a cumulonimbus. The choice of the year 2019 over Baghdad city between the two latitudes (33.375º - 44.375º) North and longitudes (33.375º - 44.375º) East latitudes. Otherwise, the daily and monthly mean of *Tp* mm/month, as well as the relationship between *Tp* mm/month and stations. The results showed that the largest amount of total precipitation occurred on 1 April 2019 (3:00 pm) for Baghdad station whereas the thunderstorm appeared to form on 31 March 2019 and developed on day 1 April 2019 and then began to dissipate on 2 April 2019. Where many types of clouds are appeared where the weather is unstable and produce moderate to heavy rainfall. This is due to meteorological and astronomical factors, climatic changes, and the nature of the surface. Correlation. As well as the highest amount of rainfall occurred on 28/02 - 28/04/2019 due to the presence of Cb and Ns clouds.

Keywords: Dynamics, Iraq, Rainfall, Relative humidity, Temperature.

1. Introduction

The regional and seasonal variations of precipitation are very important for water resources planning and hydrologic studies [1, 2]. Rainfall can be defined as precipitation in the liquid form [3].

1.1. Types of rainfall

Rainfall has been classified into three main types: Orographic or relief rainfall and Cyclonic or frontal rainfall also to Convectional Rainfall [4, 5]:

- The type of clouds formed during the convection process is known as cumulonimbus clouds.
- Convectional storms occur in many different geographic locations but are more severe in tropical areas where water sources are abundant and climates are warmer.
- They are also more severe in warmer mountain regions, see Fig. 1.

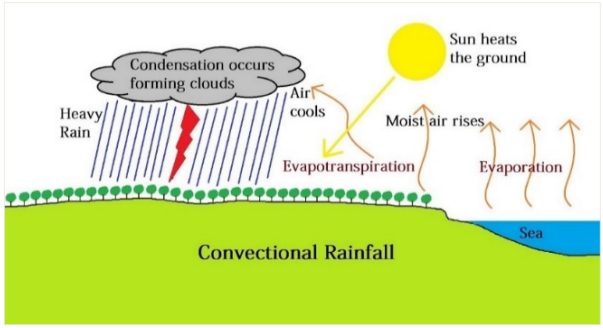


Fig. 1. The Convectional rainfall [6].

1.2. Rainfall of Iraq

The systems responsible for the fall of rain in Iraq are depression Mediterranean, depression Sudanese, and the Red Sea depression [7]:

- The Mediterranean Low comes from the Mediterranean Sea and causes rain in northern Iraq and some central Iraq according to its strength and the air front that is associated with it and causes heavy rains throughout Iraq when it merges with the Red Sea Depression and if the front is air with it wet and moderate. It causes a slight temperature rise and if it is the air front is cold with it, causing a decrease in temperature and rain [8, 9].
- The Sudanese Low is active during the autumn season and continues into winter sometimes and interacts a lot with the Red Sea depression and the Mediterranean Sea, and it feeds these depressions with great humidity due to weather instability, and the source of the depression is the State of Sudan [10].
- The Red Sea Low is a thermal depression that originates over the Red Sea to separate two air rises over the deserts of the Arabian Peninsula and the Sahara Desert [11].

1.3. Rainfall intensity

Precipitation intensity has been defined as the ratio of the total amount of rain (precipitation depth) that falls during a given period to the duration of the period and is

expressed in-depth units per unit time, usually as millimetres per hour (mm /hour). Depending on its intensity, precipitation is classified into the following three types [12]:

- Light rain: Its falling rate is up to 2.5 mm/h.
- Moderate rain: Intensity ranges from 2.5 to 7.5 mm/h.
- Heavy rain: Its falling rate is greater than 7.5 mm/h.

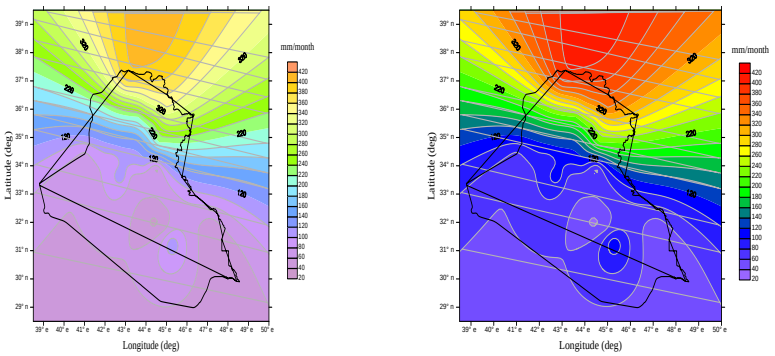
2. Source of Data and Study Stations

Data were taken from the European centre for Medium-Range Weather Forecast (ECMWF) for average daily and monthly total precipitation for 2019 and twice (03:00 am - 3:00 pm) over Iraq [13, 14]. Since Iraq is located within the arid and semi-arid region, it is characterized by the variation in precipitation from year to year. The northeaster part of the Arab world extending between latitudes (29.5-37.22) degrees north and longitudes (48.45-38.45) degrees east [15, 16].

3.Results

3.1. The total monthly mean of to

The total monthly mean of *Tp* mm/month, over Iraq. Where the highest mean 2019 year of the *Tp* mm/month, was in Emadiyah where was amount *Tp* 392.6782 mm/month during the time (03:00 am) while was in 391.4047 mm/month, during the time (03:00 pm), see Figs. 2(a) and (b).



(a) **(b)**

Fig. 2. The total monthly mean of *Tp* mm/month, (a) at (03:00 am); and (b) at (03:00 pm), over the Iraq stations.

3.2. The analysis of the daily mean of total precipitation for Iraqi stations

The largest amount of Total precipitation occurred on 01/04/2019 (03:00 pm) for Mosul station and 01/04/2019 (03:00 am) for Baghdad station and 28/01/2019 (03:00 pm) for Rutba station while 25/03/2019 (03:00 am) for Basra station. Where many types of clouds are appeared where the weather is unstable and produce moderate to heavy rainfall. This is due to atmospheric and astronomical factors, climatic changes, and the nature of the surface. As shown in Table 1, Figs. 3 and 4.

Table 1. The highest *Tp* in the stations of Iraq.

Station	Mosul	Baghdad	Rutba	Basra
Day	01/04/2019 (03:00 pm)	01/04/2019 (03:00 am)	28/01/2019 (03:00 pm)	25/03/2019 (03:00 am)
Tp mm/month	0.032431718	0.036259908	0.019085865	0.020457859

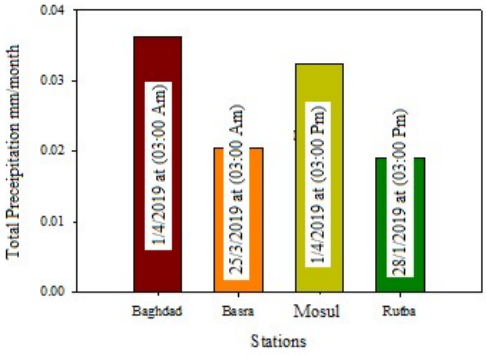


Fig. 3. The highest daily mean of total precipitation for Iraqi stations.

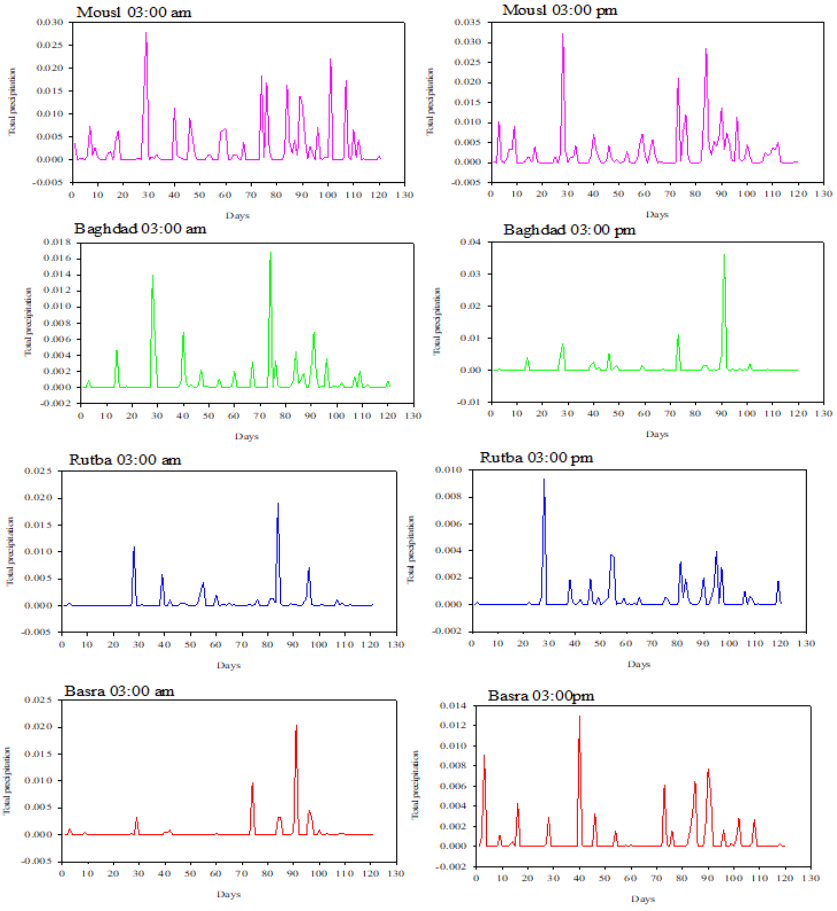


Fig. 4. Analysis of the daily mean of total precipitation over Iraq.

3.3. The analysis of the monthly mean of total precipitation for Iraqi stations

The largest amount of total precipitation occurred for Mosul station where was 301.5107 mm/month and the smallest amount of total precipitation occurred for Rutba station where was 57.8602 mm/month for the time (03:00 am). While the largest amount of Total precipitation occurred for Mosul station where was 300.7543 mm/month and the smallest amount of Total precipitation occurred for Rutba station where was 58.0640 mm/month for the time (03:00 pm). This is due to atmospheric and astronomical factors, climatic changes, and the nature of the surface also or near or far from water regions and Pressure systems, and wind blow systems see Fig. 5.

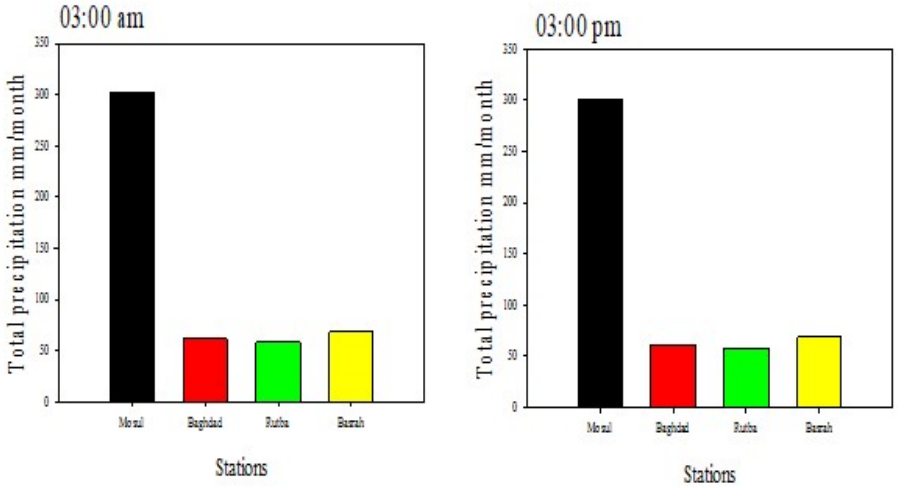


Fig. 5. Analysis of the monthly mean of *Tp* for study stations.

3.4. The analysis of thunderstorms for four stations in Iraq

The largest amount of total precipitation occurred on 1 April 2019 (03:00 pm) for Mosul station whereas the thunderstorm appeared to form on 31 March 2019 and developed on day 1 April 2019 and then began to dissipate on 2 April 2019, see Fig. 6.

This also happens in other study stations on different days for (Baghdad, Rutba, and Basra) stations, see Figs. 7, 8, and 9, respectively, where many types of clouds are appeared where the weather is unstable and produce moderate to heavy rainfall. This is due to meteorological and astronomical factors, climatic changes, and the nature of the surface.

As those days with the highest amount of rain were accompanied by a very high rainstorm. Damage that results from thunderstorms is mainly inflicted by downburst winds, large hailstones, and flash flooding caused by heavy precipitation.

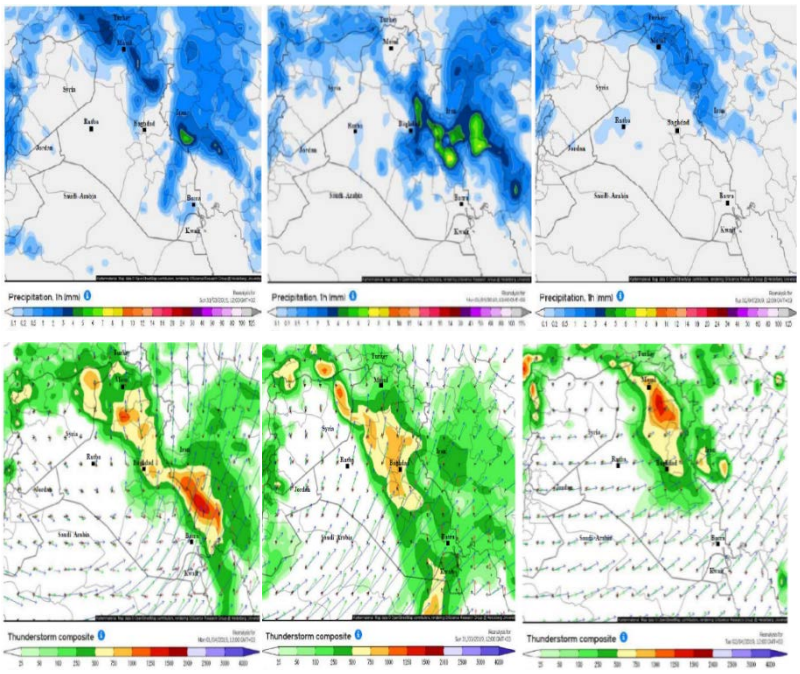


Fig. 6. The largest amount of total precipitation occurred on 01/04/2019 (03:00 pm) for Mosul station whereas the thunderstorm appeared to form on 31/03/2019 and developed on day 01/04/2019 and then began to dissipate on 02/04/2019.

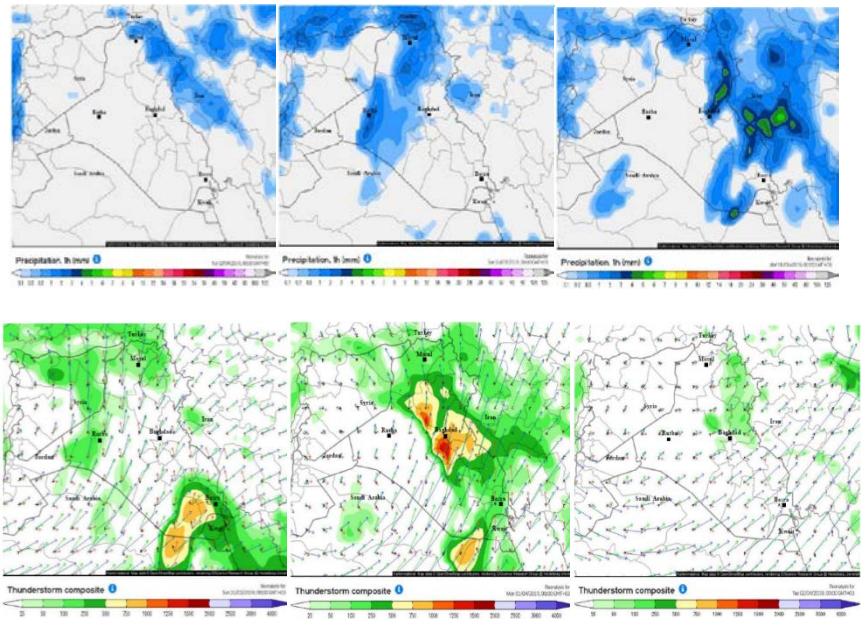


Fig. 7. The largest amount of total precipitation occurred on 01/04/2019 (03:00 am) for Baghdad station whereas the thunderstorm appeared to form on 31/03/2019 and developed on day 01/04/2019 and then began to dissipate on 02/04/2019.

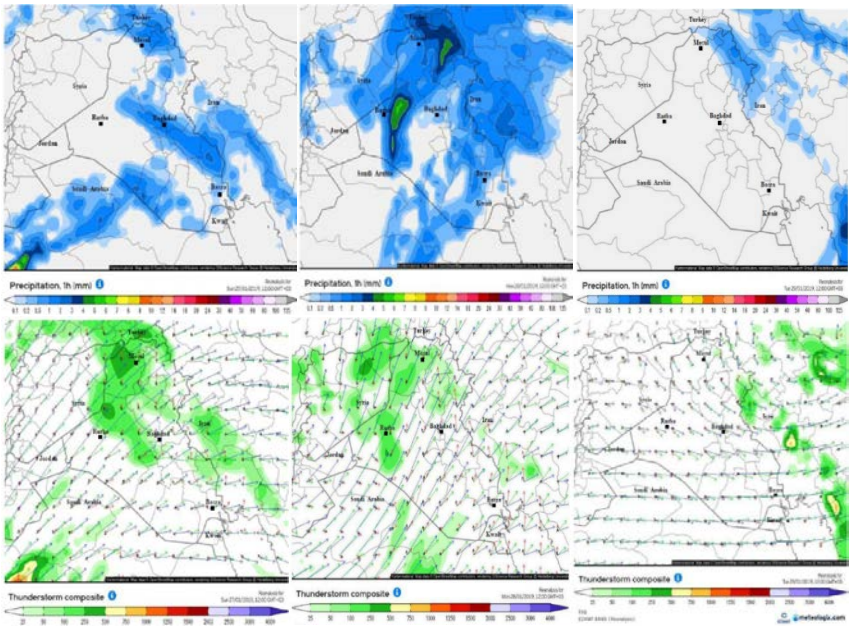


Fig. 8. The largest amount of total precipitation occurred on 28/01/2019 (03:00 pm) for Rutba station whereas the thunderstorm appeared to form on 27/01/2019 and developed on day 28/01/2019 and then began to dissipate on 29/01/2019.

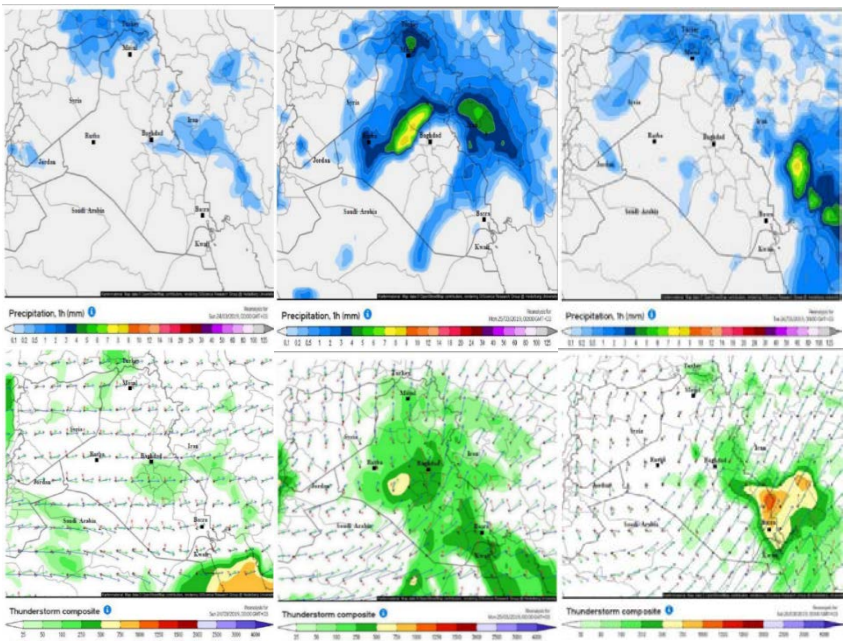


Fig. 9. The largest amount of total precipitation occurred on 25/03/2019 (03:00 am) for Basra station whereas the thunderstorm appeared to form on 24/03/2019 and developed on day 25/03/2019 and then began to dissipate on 26/03/2019.

4. Conclusions

This paper presents a new idea for the dynamic analysis of thunderstorms, determining the path of the thunderstorm from its source to the location of the occurrence of the thunderstorm over Iraq, depending on the total precipitation, through discussion of the results and presenting the figures, the following conclusions was obtained:

- The highest monthly mean 2019 year of the *Tp* Was in Emadiyah where was amount *Tp* 392.6782 mm/month during the time (03:00 am) while was in 391.4047 mm/month, during the time (03:00 pm).
- The largest amount of Total precipitation occurred on 01/04/2019 (03:00 pm) for Mosul station and 01/04/2019 (03:00 am) for Baghdad station and 28/01/2019 (03:00 pm) for Rutba station while 25/03/2019 (03:00 am) for Basra station.
- The largest amount of Total precipitation occurred for Mosul station where was 301.5107 mm/month, and the smallest amount of Total precipitation occurred for Rutba station where was 57.8602 mm/month for the time (03:00 am).
- While the largest amount of Total precipitation occurred for Mosul station where was 300.7543 mm/month and the smallest amount of Total precipitation occurred for Rutba station where was 58.0640 mm/month for the time (03:00 pm).

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