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Synoptic Analysis for the Daily Rains of the City of Baghdad

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ABSTRACT

To know the reasons for changing the daily rainfall amount, cases study were chosen for Baghdad station by specifying the maximum and minimum daily rain for the months of the rainy season for each year of the study period (2007-2018). The behavior of daily rainfall for the rainy season varying temporally with maximum (89 mm) and minimum (0.1mm). Synoptic analysis of weather chart for pressure levels (300, 500, 700, 850, and surface) was performed. Visible images of satellites were used to determine the quantities of the cloud for the selected cases. The results showed that synoptic analysis in all cases occurs due to the presence of a jet stream in the upper atmosphere, accompanied by the presence of a basin at the level of 300 hectopascals with an enhancement of relative humidity exceeding 70% at the level of 700 hectopascals, but the presence of the front makes the amount of rain greater in the absence of it. At the level of 850 hectopascals and the surface, the depressions that affect Iraq also differ in their severity and the amount of moisture loaded.

KEYWORDS: Baghdad, Rain, Synoptic analysis.

الخلاصة

لمعرفة أسباب تغيير كمية الأمطار اليومية ، تم اختيار دراسة حالة لمحطة بغداد من خلال تحديد الحد الأقصى والأدنى للمطر اليومي لأشهر موسم الأمطار لكل سنة من فترة الدراسة (2007-2018). يختلف سلوك هطول الأمطار اليومي لموسم الأمطار مؤقتًا بحد أقصى (89 ملم) وحد أدنى (0.1 ملم). تم إجراء تحليل سينوبتيكي لخرائط الطقس للمستويات الضغطية (300 ، 500 ، 700 ، 850 والسطحية) ، وتم استخدام الصور المرئية للأقمار الصناعية لتحديد كميات السحابة للحالات المختارة ، وأظهرت النتائج جميع الحالات للايام الممطرة بسبب وجود تيار نفاث في الغلاف الجوي العلوي مصحوبًا بوجود حوض عند مستوى 300 هيكتوباسكال مع زيادة الرطوبة النسبية التي تزيد عن 70٪ عند مستوى 700 هيكتوباسكال ، لكن وجود الجبهة يجعل المقدار من الأمطار أكبر في حالة عدم وجودها على مستوى 850 هيكتوباسكال والسطحية، تختلف المنخفضات التي تؤثر على العراق في شدتها وكمية الرطوبة المحملة.

INTRODUCTION

The Iraqi climate is classified as the dry and warm region in summer, and cold and rainy in winter. Rainfall values for the rainy season in Baghdad vary from season to season and with a Standard deviation 56 for the period (1970-2001) [1] . Winter month receives about 42-56 % of the annual rainfall and thus it represents the wettest season of the year while the vernal season receives a valuable amount rainfall and contributes 27-32 % of the total annual rainfall. The autumn season contributes 15-27 % of the total annual rainfall [2]. The amount of annual rainfall mainly depends on the type of the Pressure system (cyclone), location of the region and its intensity and speed and period of continuity and the amount of moisture loaded[3] , all these factors are major reasons to causes of the different amount of rainfall.

The synoptic analysis is considered one of the best ways to explain the reasons for the variation in rainfall quantities Therefore, there are many global and local studies interested in this field. Basim Ibrahim et al (2015) studied the synoptic analysis rainy case on 12/25/2012. Note that the amount of rain in Baghdad was (5.6mm) and the reason for this was explained by the presence of a local air depression, which merged with the secondary depression coming from Saudi Arabia. Hirata *et al.* (2017) studied the evolution of rainfall extremes during austral spring, fall and winter over southeastern South America and they found that warm ENSO phases tend to favour more frequent extremes in all three seasons and extreme events during El Niños are associated with synoptic waves, with no significant

interaction with intraseasonal anomalies[4]. Brasiliense *et al*. (2018) analysis of the first South Atlantic convergence zone (SACZ) event of the year 2000 which caused high volumes of rain in southeast Brazil, the episode mean circulation showed well known characteristics such as a Bolivian high, a northeast cyclonic vortex and a continental trough in the upper troposphere. In the lower levels an extensive low- pressure region over the continent, moisture convergence and strong upward movement typical of SACZ events were present. A dipole blocking pattern over the Rio Grande do Sul state and Uruguay, composed of a cold low and a warm high in the upper troposphere, had significant importance in this case[5]. While Kiani *et a*l. (2019) studied the effect of the Zagros Mountains on rainfall changes of Sudanese low-pressure system in western Iran. The result showed that suitable thermodynamic conditions have provided for the growth and strengthening of the convection clouds and severe precipitation on the surface of the regional topography. Thus the conveyance of humidity and instabilities has occurrence inward the region. These conditions increased the intensity of the upward movement of the air, the growth of the cloud and the occurrence of heavy rainfall in the steep slopes and the southern and southeast slopes of Zagros[6] . Malik Naser et al. (2020) studied synoptic analysis for the rain whose quantities range between (11-20.9 mm), which is a standard that varies from region to region according to the difference in the type of rain, its quantity and system, and the term abundance depends on the amount of rain precipitation, its duration and intensity, and the cause that created total heavy rainfall has reached (135) rain. During the study period from (2006-2016), the surface air depressions contribute to the occurrence of heavy rains, and their intensity increase according to the characteristics of these depressions and another[7] . Recently, Yang Ai and Weihong Qian (2020) studied the anomaly-based synoptic analysis that is applied to identify the features and structures of the anomalous synoptic systems during the event period. Results showed that the heavy rainfall occurred along the trough of anomalous geopotential height (GPH) and the shear line of anomalous winds at the low troposphere. The anomalous synoptic analysis, by removing the temporal climatology from the total variables, can directly reflect the large-scale features of the event, which includes the actual position of the Baiu front, the pathway of anomalous moist air masses associated with anomalous synoptic systems such as the anomalies of Okhotsk cold high and the Northwest Pacific subtropical high. Meanwhile, the opposite signs between 200 and 850 hPa GPH anomalies, which match observed rainfall records well, could be a good indicator of the potential heavy rain period. The product of the ensemble prediction systems from the European Centre for Medium-Range Weather Forecasts can predict such potential anomalous signals of the Heavy Rain Event for 4–5 days in advance[8]. The aim of this search study the synoptical analysis of the daily rainfall for period (2007-2018)

The Controlling Factors on Rainfall

The difficulty of studying the rainfall in Iraq is through the multiplicity of factors responsible for its composition, namely[9]:

1- Characteristics of frontal depressions.
2- Characteristics of Clouds.
3- Characteristics of air masses.
4- Terrain.
5- Characteristics of the upper atmosphere.

The characteristics of the depressions and fronts, which are considered the largest responsibility for the rainfall also the dominant situation in the upper atmosphere, it's responsible for rain in Iraq. For that, Synoptic Analysis Charts often used to obtain the basic information about rainfall. Important level pressure used for Synoptic Analysis is:

Level 850 mb is located at about 5000 ft above flat land near sea level as a stander. This height can be changed for several hundred feet that depend on surface elevation, season, time of the day, and the ongoing weather system. Sometimes 850 mb level merges worth planetary Boundary Layer, especially during summer. Chart of 850 mb level is important to locate frontal systems especially when there is difficulty in determining the fronts on the surface chart. The 850 mb front almost found pole ward of the surface front [10]

Level 700 mb is located 10,000 ft above the ground and maybe within part of the planetary boundary layer during the warm season. This is especially true of the higher mountainous regions. Weather systems at 700 mb typically take on an open, broad look compared to the patterns at lower levels. The fronts are usually found further

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pole ward compared to the 850 mb and surface charts, owing to the slope of fronts up and into the cold air. This relationship can help to place the low-level front when the 700 mb chart shows a thermal gradient and the 850 mb and surface charts don't have a clear position [10]

Level 500 mb is considered the middle of the troposphere. It is located 18,000 ft in Polar Regions, and so is nearly always within the free atmosphere and not part of a planetary boundary layer. At this level, forecasters see an excellent mix of small-scale and large-scale systems. At the large scale, the upper-level jet pattern begins emerging, painting out the regions of strongest baroclinicity (energy available to the atmosphere). Superimposed on this is a series of large troughs and ridges. The troughs correspond to vary cold air masses, while the ridges exist above areas of warmth.

Level 300 mb is usually located of 30,000 ft, it is used primarily to establish the pattern of upper level jets, to locate areas of shear and to assess the nature of the hemispheric circulation and identify any blocking patterns. The practicing meteorology always wants to have a glance at the upper tropospheric conditions, as the polar front jet lies in its topmost portions[11].

Level Surface is the backbone of weather forecasting and is the most familiar map to anyone who has dabbled in meteorology. The biggest advantage of the surface chart is that data is available quite frequently as often as six hours in remote regions and 20 minutes in North America. This chart important use for search imbalances that reflect processes occurring aloft, which may not be reflected by the coarse radiosonde data that is only available every 12 hours [12].

MATERIALS AND METHODOLOGY

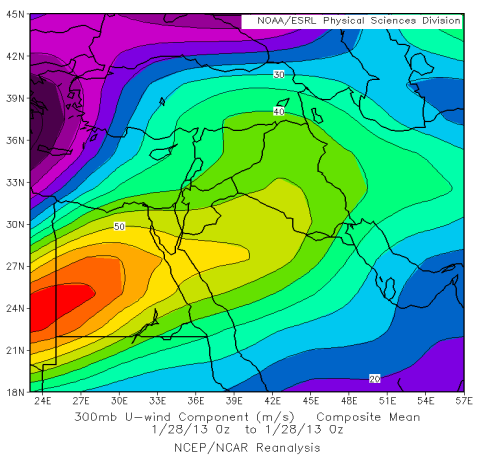
Study Area and data: The observed daily rainfall (mm) data of Baghdad station in Iraq of rainy seasons for (2007-2018) taken from Iraqi Meteorological Organization and Seismology (IMOS). Synoptic Analysis of daily rainfall to know the reasons for changing the daily rainfall amount, cases study was chosen for Baghdad station by specifying the maximum and minimum daily rain for the months of the rainy season for each year of the study period.

Synoptic analysis of weather chart for pressure levels (300, 500, 700, 850 and surface) was performed 300 mb for Geostrophic wind to show the presence of a jet stream from absence, level 500 mb for geopotential height to determine the location of trough and ridges while 500mb for the temperature to find out cold or warm air mass, 700 mb level for relative humidity indicates a deep layer of moisture. Use 700 mb chart in combination with surface and 850 charts to determine depth of moisture, 850 mb level for geostrophic wind. If the wind change is significant, it indicates that there is a front finally surface for temperature determine to locate the front. Visible images of satellites were used to determine the quantities of the cloud for the selected cases. Cases of January show as an example for analysis.

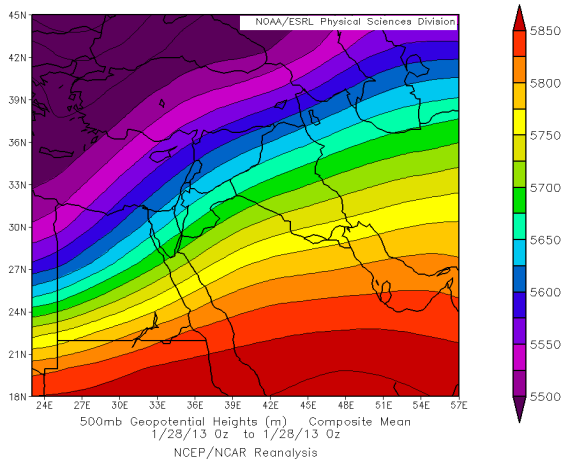
RESULTS AND DISCUSSION

Case of January maximum of rainfall was (47.3 mm) occurred on 28/01/2013 by analyzed 300 mb chart a jet stream was presence west of Iraq with core speed (65 m/s), the Figure1a. Iraq falls within a transitional zone between the trough and ridge as shown in the 500mb chart, in Figure1b air temperature from 500mb chart, in Figure1c cold air mass middle and north Iraq. In 700 mb chart the humidity approaching (70-80%) over Baghdad as shown in **Error! Reference source not found.**). From the Figure (1e) notice a cyclonic in the northeast of Iraq and large change of wind speed in 850mb chart, which indicates the presence of front, and this is confirmed by the surface map as shown in Figure (1f), where Figure (1g) shows, the large amount form clouds covering Iraq.

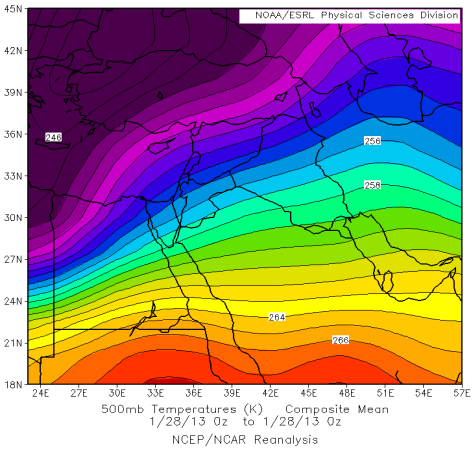
1a



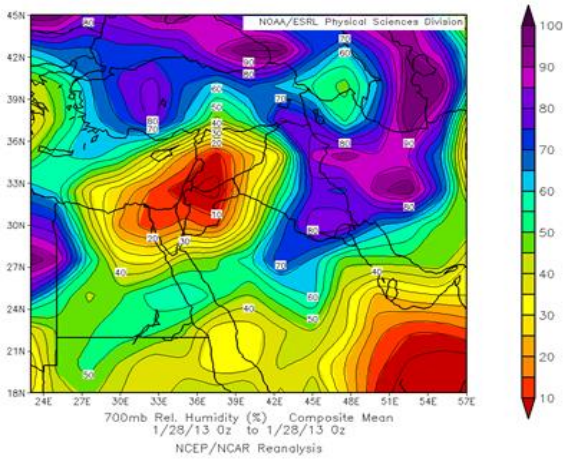
1b



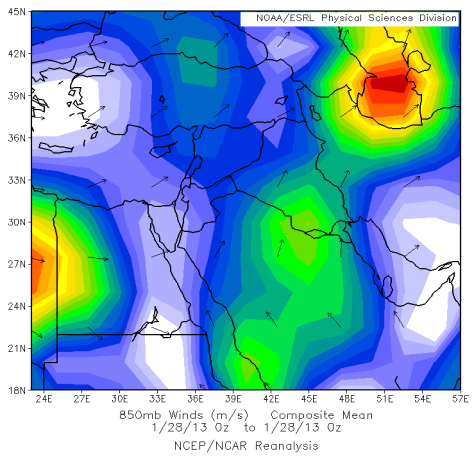
1c



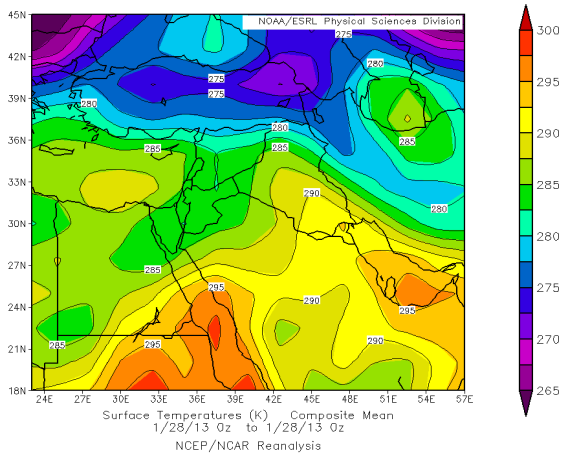
1d



1e



1f



1g

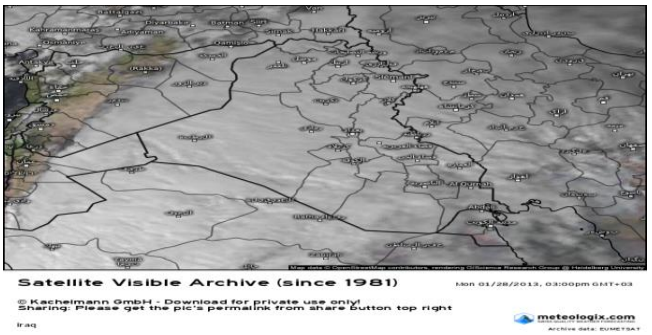


Figure 1. All level chart sand satellite image of the case (28/01/2013).

While the minimum quantity of rainfall (1 mm) occurred on 11/01/2007. By analyzing 300 mb chart a jet stream was presence in southern Iraq with core speed (60m/s) North Iraq falls within a trough as shown in the 500mb chart discuss air temperature from the 500mb chart cold air mass north Iraq. In 700 mb chart the humidity approaching (10 - 20%) over Baghdad. noticed no change of wind speed in the 850mb chart, which indicates no front, and this was confirmed by the surface map. Satellite image of this case shows a few amounts of clouds covering Baghdad and south Iraq, as shown in Figure (2).

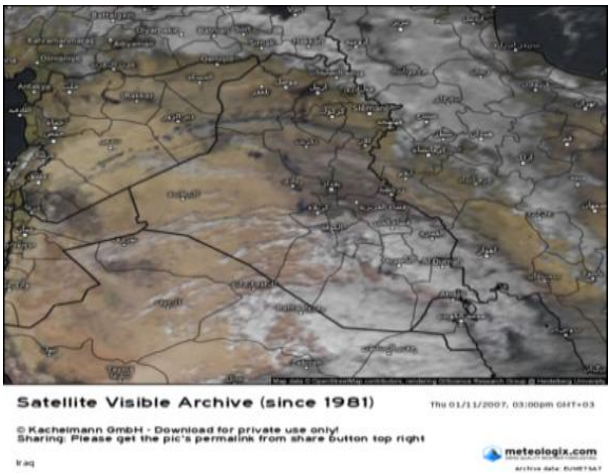


Figure 2. All level charts and satellite image of the case (11/01/2007).

The same procedure is performed for the rest months in February maximum quantity of rainfall (21.3 mm), the jet stream passes over southern and eastern Iraq, it is clear that there is a good humidity in the north and center of Iraq and the southwestern region between (60 to 100) percent, it appears that the center of the depression through wind movement is located in the west of Egypt. It includes a cold front, a warm front, and a low front, Satellite image of this case shows the amount of large clouds covering most Iraq. In February, minimum rainfall (0.6 mm), the jet stream is far from Iraq and descended on Egypt and Red Sea region, there is not enough moisture to supply the rainfalls except for northern Iraq, moisture is present in medium quantities, and unlike the northern and southern regions outside the borders of Iraq (Saudi Arabia and Turkey), that there is no frontal system in Iraq. Satellite image of this case shows some clouds covering Iraq.

In March maximum rainfall was (19.4mm), temperature indicates the presence of a cold basin that affects northern and western Iraq due to instability and may activate a low-pressure area on the surface, such as being the Red Sea low. The presence of high humidity ranging from (60- 80) percent in western, central and eastern of Iraq, which is a good quantity of rainfall, it is clear from the map of Iraq, Satellite image of this case shows some cloud over Baghdad and the amount of large clouds covering west Iraq. In March rainfall was (0.1mm) on its minimum, the jet stream is in southern and central of Iraq, moisture in good quantities in western and northern of Iraq. As for the center and south, the humidity will be moderate to low. This indicates that there is a shallow depression on the eastern Mediterranean region and a frontal depression in Yatter, northern Iraq, more than other regions. Satellite image of this case shows a few amounts of clouds covering Iraq.

In April maximum quantity of rainfall (27.8 mm), the jet stream west and southwest of Iraq. This situation causes instability where a surface air depression is activated, which may be in the Red Sea depression. There is a very excellent humidity in northern and central of Iraq, which stays between (80-100) percent, this helps for good rainfall. The state of instability as a result of the upper cooling activates the convective condition over Iraq, which enhances the state of rainfall over Baghdad. Satellite image of this case shows the large amount of clouds covering Iraq. In April minimum quantity of rainfall (0.8 mm), the jet stream is located above central Iraq, is no good supply of moisture in the central, southern and western regions of Iraq, as shown that the center of the depression is centered in southern Iraq and there is no front in Baghdad. The satellite image of this case shows a few amounts of clouds covering central and northern Iraq.

In May maximum quantity of rainfall was (10.7 mm), the jet stream is in the south of Iraq. There is a very high humidity supply ranging from (70-100) percent in the center, southwest and southeast of Iraq. That there is no front over Iraq, but it is located over the Mediterranean Sea, and this situation enhances the state of rainfall in the central, southwestern and southeastern regions of Iraq. Satellite image of this case shows the amount of large clouds covering Iraq.

In May, the minimum quantity of rainfall is (0.3 mm), the jet stream is located over central, southern and northeastern regions of Iraq. There was no good supply of moisture, and this didn't enhance the rain, especially in the study area. Satellite image of this case shows a few amounts of clouds covering Iraq.

In October maximum quantity of rainfall was (54.1mm), the jet stream, it is clear that it is located in southern and eastern of Iraq, and this indicates the presence of trough at the lowest levels. Humidity showed good nutrition for humidity over central of Iraq up to 100% as it contributes with instability to torrential rains. Satellite image of this case shows the amount of large clouds covering Iraq. In October, minimum quantity of rainfall is (0.2 mm), the jet stream is centered over southern Iraq, moisture feeding are sub-average (60%) feeding over central Iraq so that does not help with good rains there is also no accompanying surface front, a Satellite image of this case shows same amount clouds covering Iraq.

In November, the maximum quantity of rainfall was (89.1mm), the jet stream passes in southern Iraq, the moisture is very good estimated over central and southern of Iraq, which enhances the chances of heavy rains. Satellite image of this case shows the amount of large clouds covering Iraq. In November, the minimum quantity of rainfall was (0.2 mm), the jet stream over the southwest of Iraq, and there was not enough moisture for heavy rainfall. Satellite image of this case shows no clouds covering Iraq.

In December, the maximum quantity of rainfall was (67.1mm), the jet stream is centered over southeastern of Iraq, excellent amounts of humidity in eastern of Iraq up to 100%, which enhances the chances of heavy rainfalls. Satellite image of this case shows the amount of large clouds covering Iraq. In December minimum quantity of rainfall (0.1 mm), the jet stream passes over central and southern Iraq, moisture processed at a height of 700, which leads to poor precipitation. Satellite image of this case shows the amount of same clouds covering Iraq.

In all cases, the presence of the jet stream was found to be important, whether the amount of rain was maximum or minimum and this was confirmed by a study of the impact of jet stream and associated mechanisms on winter precipitation in Pakistan that tested the presence of the jet stream on wet and dry days.

The strengthening of humidity and the continuation of its flow from the upper atmosphere leads to an increase in the amount of rain, especially if it is associated with a surface air front. This analysis is identical to the heavy rain conditions that were analyzed found factors primarily responsible for heavy rainfall event included the prolonged concentration of two very moist airstreams over western Japan and persistent upward flow associated with activation of the stationary Baiu front.

CONCLUSION

The behavior of daily rainfall for rainy season varies from temporally with maximum (89 mm) and minimum (0.1mm). From synoptic analysis for rainy cases, show that the reasons of this varying are that all cases occur due to the presence of a jet stream in the upper atmosphere , accompanied by the presence of a trough at the 300 mb level with reinforcement in relative humidity exceeding 80% at the 700 mb level. However, the presence of the front makes the rainfall quantity larger in the absence of them in level 850 mb. This is due to the nature of the depressions that affect Iraq and sometimes merge, causing severe rainfall.

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