

# Dynamical Analysis of Severe Rain Events over Iraq

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## Abstract

Rainfall is considered as the most difficult meteorological parameter to measure because it is highly variable temporally and spatially. Rainfall happens over Iraq in transition seasons and in winter and this shows that the rainfall depends on the general circulation pattern. The aim of this research is diagnosing Dynamic analysis extreme rainfall over the Iraq and border regions of surrounding countries and the data were taken from European Center for Medium Range Weather Forecasting, ECMWF), satellite image and diagram for radiosonde for the 2015 Through chosen metrological parameters affecting rainfall intensity. The result Most of rainfall is located in the eastern part of Iraq as in case 22 April 2011 the rainfall occurred from north to south with maximum daily rainfall is about 30-40 mm in the northeast region depending to image from TREM is very accurate and through it determine the intensity of rain more than other means, The cases extreme rainfall accompany The temperature has variance between northern and southern of Iraq, its arrived about 10 °C ,addition to the clouds cover most of found in levels of pressure about 800-500 hPa this means that the clouds are low and rainy, This study shown the high percentage of relative humidity found out in 700 hPa, more than 850 hPa, that's because of near to the surface, the turbulence is increased toward surface so that 700 hPa is more stable than 850 hPa, reduced vertical velocity and the wind become geostrophic wind in 700hpa. The positive relative vorticity is dominant over Iraq in 500 hPa. When the cyclonic spin while upward vertical motion.

**Keywords:** Rainfall; Analysis; Iraq.

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## **1. Introduction**

Rainfall is the amount of water that falls down from clouds. That rainfall measured by many ways i.e. measurement stations is considered [1]. Rainfall classified into three types according to process of gneiss, convectional, orographic and cyclonic [2]. To diagnosing Dynamic analysis extreme rainfall over Iraq selected parameters like geopotential height, horizontal wind speed, vertical velocity, relative vorticity and relative humidity trying to find how these parameters effected by each other's when rainfall happen through their relationship with rainfall, The data for the selected parameters were

plotted by using GrADS program for forecasting region and taking the values of parameters and checking the produced maps for multi times. There are numerous research papers is analysis the Interaction between rainfall and metrology variables. Caloiero and his colleagues 2011 a statistical analysis of annual and seasonal precipitation for more than 50 years of data observed in a region of Southern Italy (Calabria). Therefore, the procedures have shown a decreasing trend for annual and winter–autumn rainfall and an increasing trend for summer precipitation [3]. Analysis for temperature data showed that all the four temperature variables (maximum, minimum, and mean temperatures and temperature range) had rising trend when they studied the monthly, seasonal, and annual rainfall and temperature on the subdivision and regional scale for the northeast region NER [4]. Precipitation happens over Iraq in transition seasons and in winter and this shows that the precipitation depends on the general circulation pattern. The relationship between precipitation amount and geopotential height is indirect, but the value of geopotential height may be repeated while the amount of precipitation may be not with the happen same amount that [5]. The study focused for rainfall variability in Beijing metropolitan region and its link to urbanization during the first 10 years of the twenty-first century (2000–09). it founded the urban area has fewer rain days and higher rainfall intensity compared to its surrounding region [6]. The studied focused on relationship between the intensity of extreme rainfall and temperature came out by PANTHOU and his colleagues in 2014 because the moisture-holding capacity of the atmosphere is governed by the Clausius– Clapeyron equation. The results refer to temperature dependence of extreme-intensity rainfalls should follow a similar relationship assuming relative humidity remains constant and extreme rainfalls are driven by the actual water content of the atmosphere and the climatic region have a strong influence on this relationship. For short durations, the  $P_{ext}-T_a$  relationship is close to scaling for coastal regions while a high scaling followed by an upper limit is observed for inland regions [7].

There are two common storm tracks in the area. In the first, storms move through the Mediterranean Sea (Mediterranean low) with multiple cloud layers (low cloud to cirrus clouds) and precipitation with the low can take from two to four days to crossing Iraq. Mediterranean storms that follow the second storm track come out of the Red Sea Trough (RST) into Jordan, Syria and Iraq on the way to the Gulf [8].

## **2. Materials and methods**

Iraq lies between latitudes  $29.03^{\circ}$  to  $37.25^{\circ}$  N and  $38.75^{\circ}$  to longitude  $48.75^{\circ}$  E. The climate of Iraq is characterized by continental, arid to semi-arid with dry hot summers and rainy winters. Rainfall is relative low in central and southern of Iraq (100-200 mm), sometimes the amount of rain reach to 1000 mm in northern of



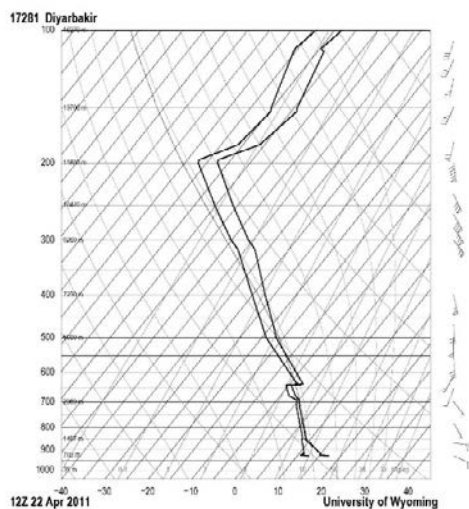
Iraq especially in rain season from November to April over Iraq [9]. about 90 percent of the annual rainfall occurs in season rain, most of these rain came from warm cloudily, rain from mediterranean sea, Red sea and Saudi Arabian sea. While they not effect by monsoon rain. These main June, July, and August the amount of annual rainfall ranges between ten and seventeen centimeters [10].

## 2.2 Data Sources

European Center for Medium-Range Weather Forecasts (ECMWF) data was the main source datasets in this research. The vertical levels (500, 850, 750, sfc. hPa) be said the data from TRMM to appear the total precipitation in surface and the data from the Radiosonde to show the cloud cover.

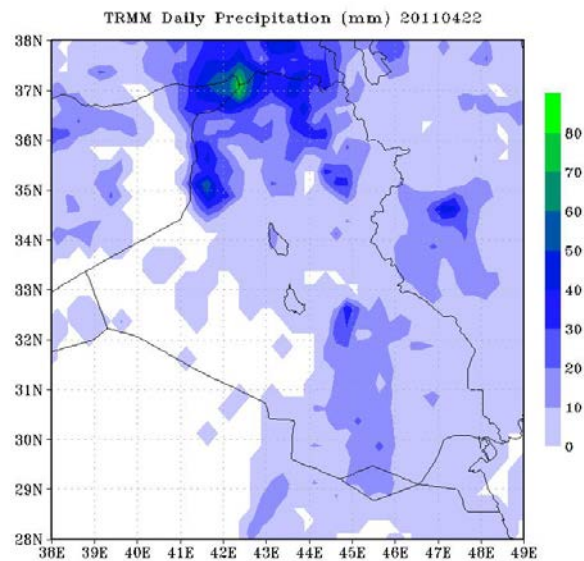
## 3. Result and discussion

The case that happen in 22 April 2011 show three categories; heavy rainfall in the northeastern Iraq and west Iran about 70-80 mm. Second category is moderate in the center, while third is low rainfall in the western region, in the figure (1) of daily data by TREMM. This distribution refers to the two reasons: the topography that led to up welling current air flow of mountain and dynamic process of transfer and structure cloud. By using upper air sounding to determine the cloud cover the represent another aspect for same case of the rainfall that's happen as show in figure (2) the most cloud is extended from 900 hPa to 650 hPa.



**Figure 1:** TRMM map of daily precipitation

for 22 April 2011.



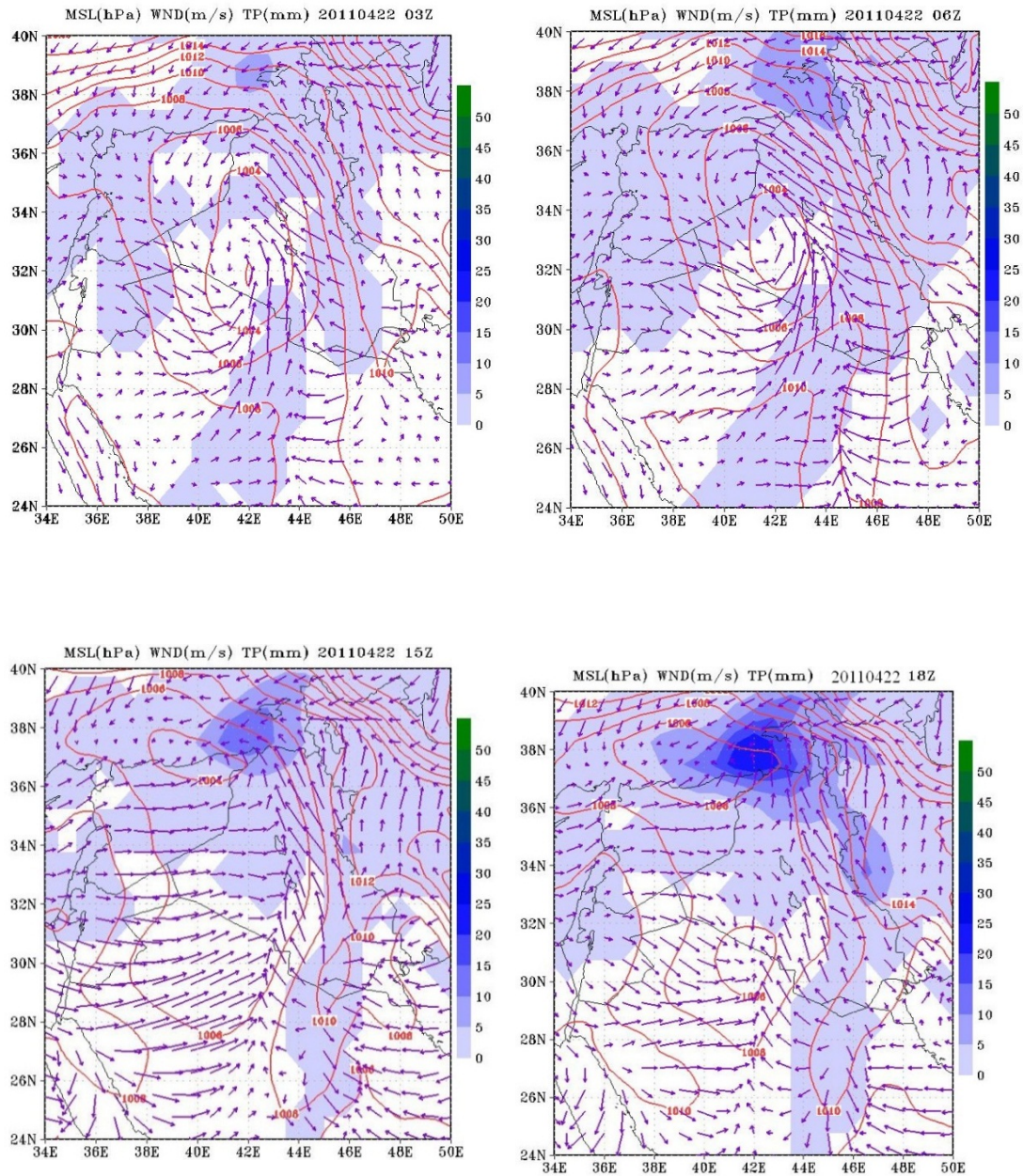
**Figure 2:** Skew diagram for Diyarbakir on 22

April 2011.

The low pressure system is located on western Iraq with center of 1002 hPa during the 03 UT. On 06 UT the system was moving from the Saudi Arabia towards Iraq in Figure (3). This low system fortunately called (red sea low pressure), the wind arrows shown that big variance between eastern and western part of Iraq, it's occurred near the center of the low pressure systems, where in the western part the wind is faster from the



eastern part and the wind direction from west at 03,06 UT, the wind direction is parallel to latitude over most of Iraq at (15,18) UT, the time variation affects to most of Iraq region has one value of TP.

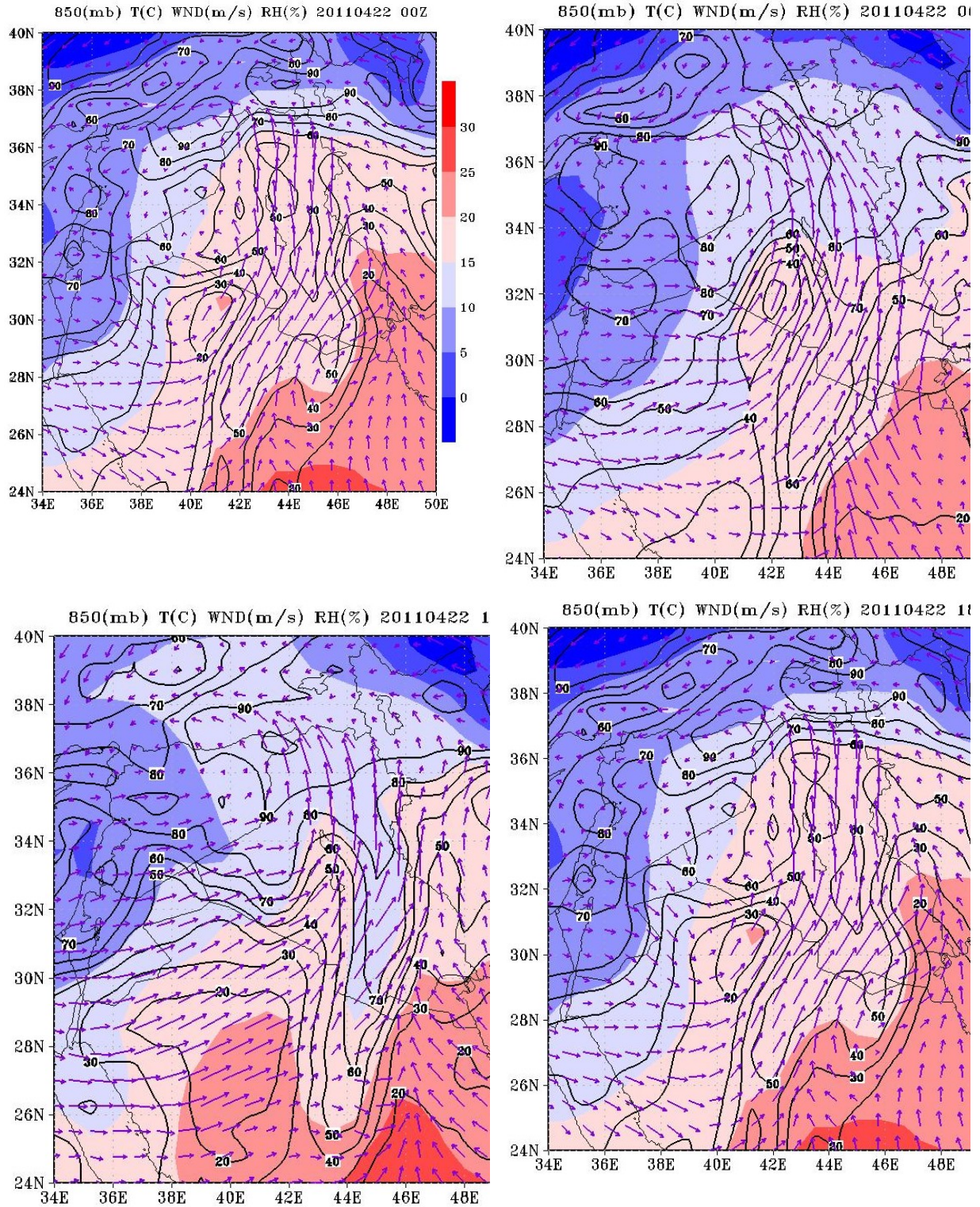


**Figure 3:** Synoptic surface maps for mean sea level pressure (contours) ,surface wind (arrows) and total precipitation (shaded) on 22 April 2011 at (03,06,15,18Z).

The synoptic maps of the 850 hPa level in Figure (4) It is seen that the temperature ranging from 10 C<sup>0</sup> (in the north) to 25C<sup>0</sup> (in the south). The relative humidity reached 80% in regions that closed to the location of the extreme rainfall, the pattern of the wind was south western. While for the 700mb level in figure (5) its seen that a two distant low geopotential height is located over the Mediterranean Sea with a value about (29200) at 12 UT and (29300) at 18 UT. The relative humidity reaches to 100% in the regions close to the rain location it is seen

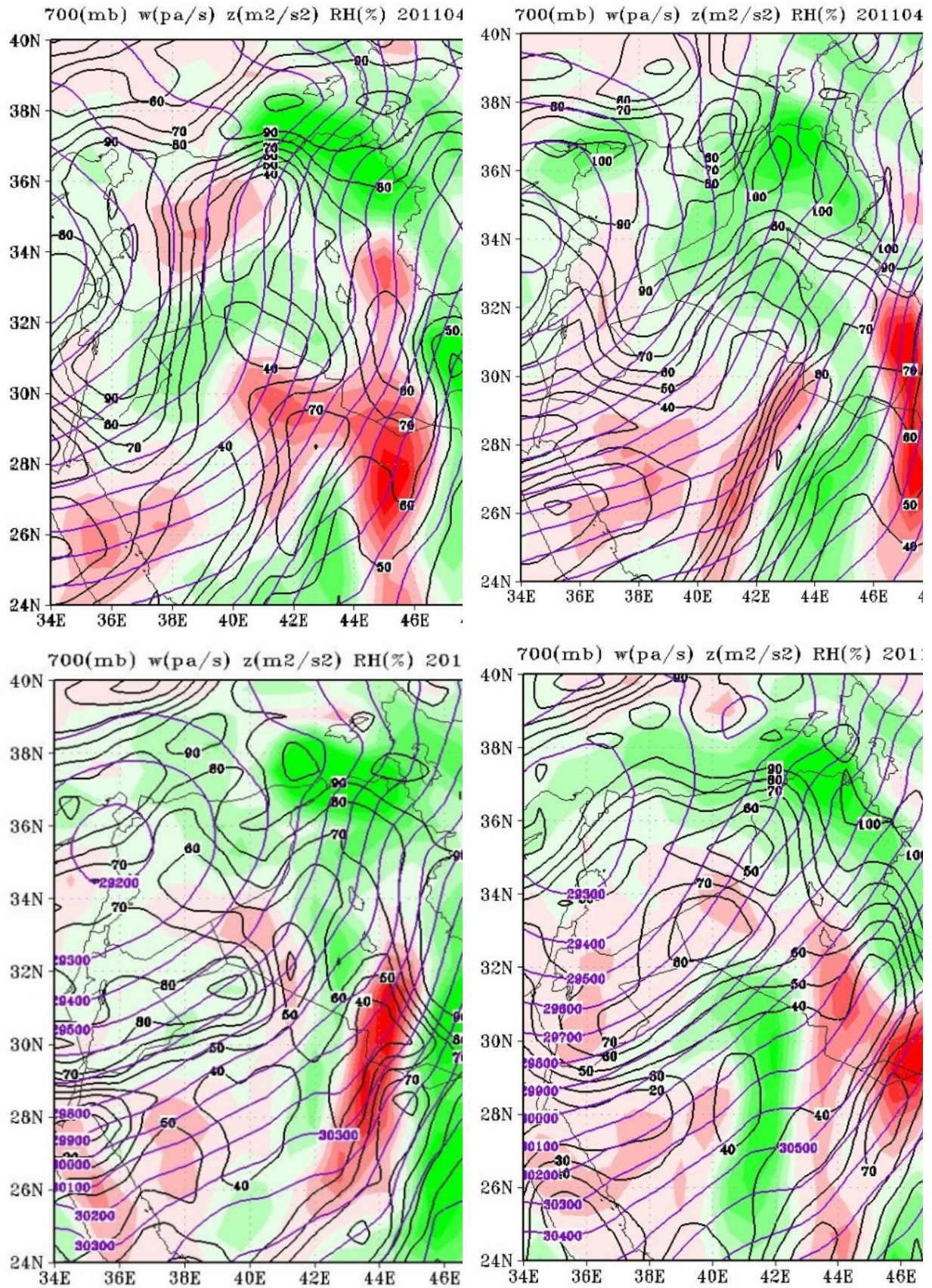


that the vertical wind was directed upward in the rainy areas.



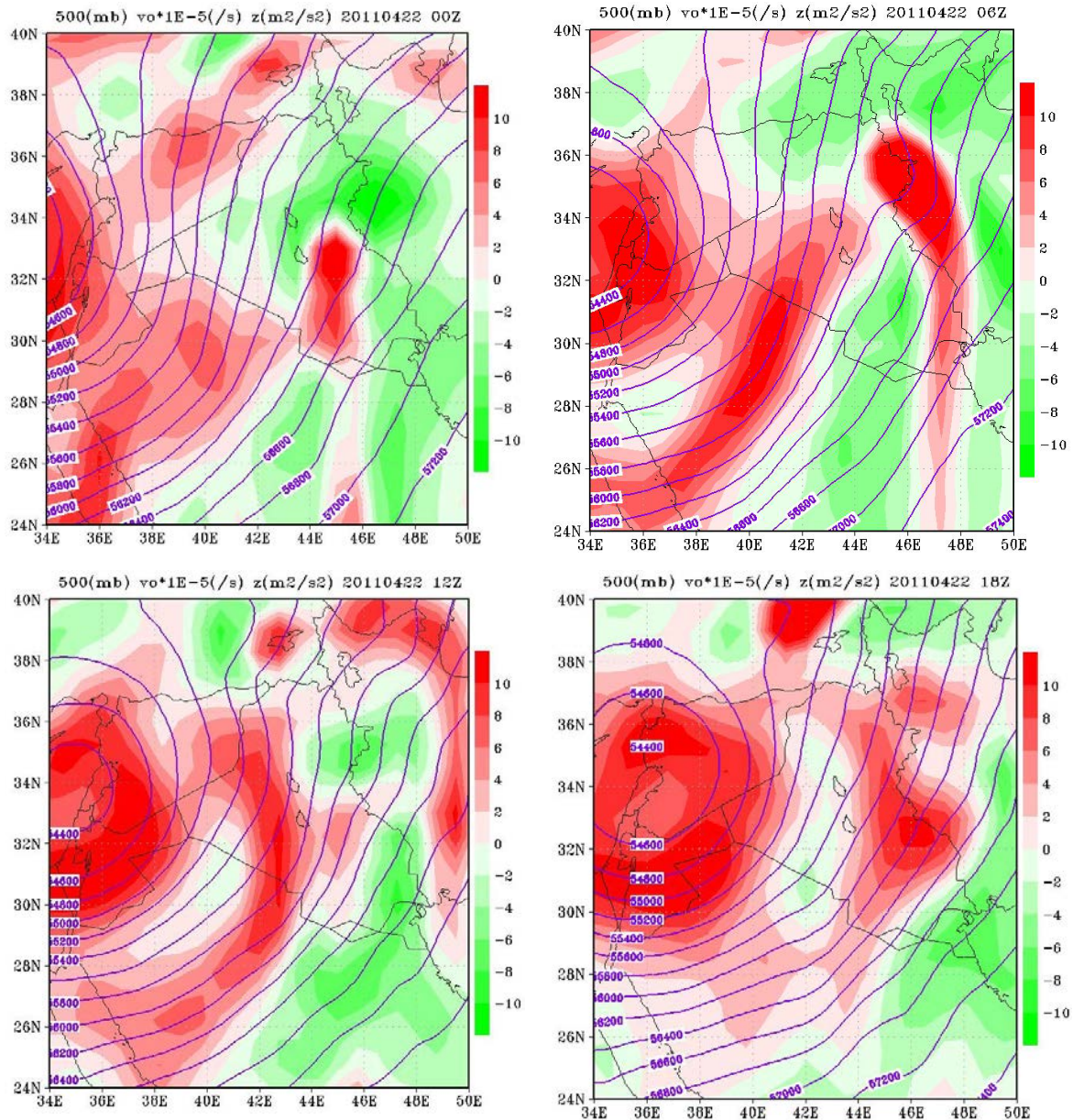
**Figure 4:** synoptic 850mb maps for temperature (shaded), wind (arrows) and relative humidity (contours) on 22 April 2011 at (00,06,12,18Z).





**Figure 5:** synoptic 700mb for vertical velocity (shaded), geopotential (purple contours) and relative Humidity (black contours) on 22 April 2011 at (00,06,12,18Z).





**Figure 6:** synoptic 500mb maps for relative vorticity (shaded) and geopotential (contours ) on 22 April 2011 at (00 06 12 18 Z).

The geopotential height in 500mb that shows low system over the Mediterranean Sea and moving eastwards Iraq and became more smoothly and Stability in figure (6), the Probability of existence cloud is very few in level 500hPa according to the reading of the radiosonde in figure (1-2), if it's found its high cloud type. It can also be seen that a positive relative vorticity was forming over Iraq from two regions one from south region and another from south east (at 00,06 UT). At 12 and 18 UT almost the entire Iraq was couriered by region of positive vorticity

#### 4. Conclusion

1. Where wind pattern for Iraq refer that most of wind direction is came from western, and southwestern so that



the rainfall sources is compatible with wind direction

2. Relative humidity is one of climatic variable that give good signal for rainfall case.
3. The low-pressure system consists during movement of the cyclone and taken different direction's according to movement of the cyclone.
4. The positive relative vorticity is dominant over Iraq in 500 hPa. When the Cyclonic spin while upward vertical motion.

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