

Study of Sub Tropical Jet Stream in Summer Season

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ABSTRACT

The jet stream has wide importance in analyzing synoptic maps because it correlates with other meteorological factors, so the study attempted to study the sub-tropical jet stream (SJS) and shows the variation ranges of atmospheric variables on its path depending on highly accurate meteorological maps obtained from (University of Wyoming), and the study tried to show the correlation with surface temperature in Baghdad city depending on data given from automatic weather station that located above Mustansiriyah university building in Baghdad. The study area covers the middle east region focusing on the subtropical jet stream and showing its correlation with the pressure system type over Iraq inside the (300) hPa level. The result showed that the highest surface temperature in Baghdad was recorded after the starting of the subtropical jet stream in its region, and the highest-pressure values in (300) hPa were over Iraq while the jet stream is passing its path. The study also showed that the sub-tropical jet stream corresponded with a higher value of temperature inside its path.

KEYWORDS: Sub tropical jet stream; 300 hPa; temperature; Iraq.

الخلاصة

للتيار النفاث أهمية كبيرة في تحليل الخرائط السينوبتيكية بسبب ارتباطه بعوامل الأرصاد الجوية الأخرى، لذلك حاولت الدراسة فهم التيار النفاث شبه الاستوائي وإظهار نطاقات التباين لمتغيرات الغلاف الجوي في مساره اعتمادًا على خرائط أرصاد جوية عالية الدقة، وقد تم الحصول عليها من (جامعة وايومنغ) وحاولت الدراسة إظهار الارتباط مع درجة حرارة السطح في مدينة بغداد بالاعتماد على البيانات الواردة من محطة الأرصاد الجوية الآلية التي تقع فوق مبنى الجامعة المستنصرية في بغداد. تغطي الدراسة منطقة الشرق الأوسط من أجل التركيز على التيار النفاث شبه الاستوائي وإظهار ارتباطه بنوع نظام الضغط فوق العراق داخل مستوى (300) هكتوباسكال. وأظهرت النتائج أن أعلى درجة حرارة سطحية سجلت في بغداد بعد بدء التيار النفاث شبه الاستوائي على منطقتها، وأن أعلى قيم ضغط كانت فوق العراق أثناء مرور التيار النفاث في مساره. كما أوضحت الدراسة أيضًا أن التيار النفاث شبه الاستوائي يتوافق مع قيمة أعلى لدرجة الحرارة داخل مساره.

INTRODUCTION

The subtropical jet stream (SJS) is produced by angular momentum and it is a result of moving air mass over time corresponding with curved lines by uniformed radius. [1]

to understand this, we must assume that there is an air mass with velocity (US) over the earth's surface on latitude (ϕ), and by knowing that the earth is rotating so the latitude line also rotates east word with the same velocity (UES), the total velocity of this mass resulted from the mass itself (US) plus (UES), but the air mass moves with opposite direction then there is no other forces acting on it and the momentum is conserved. [2]

$$M(US+UES) = M(Ud+Ued) Rd \quad (1)$$

Where: Ud represents Zonal wind on the exact latitude, Ued is the tangential velocity over the path, M is the air mass.

ϕ represents latitude, So on exact latitude

$$Rd = Re \cos(\phi) \quad (2)$$

and the tangential velocity of source on the path is

$$Ud = \Omega R \phi = \Omega Re \cos \phi \quad (3)$$

and the angular velocity of earth is

$$\Omega = 0.729 \times 10^{-4} \text{ S}^{-1}$$

Therefore

$$Ud = [\Omega \cdot Re \cos \phi_s + Us] (\cos \phi_s / \cos \phi d) - \Omega \cdot Re \cdot \cos \phi \quad (4)$$

When the upper air divergent exists over the equator line, the velocity of air increase with increasing latitude, and the zonal wind does not exceed $\pm (30)$ because of Coriolis force that causes

deflection of air direction and pressure gradient in opposite direction [3].

The subtropical jet stream helps momentum transportation toward the south with slow motion and higher speed northward, the (SJS) helps to conserve zonal wind and is located nearly (30) degree latitude with stable milder wind velocity, and extended for more than (10) degrees of latitude with (1000) km of width, and the wind velocity near (65) meter per second [4].

The subtropical jet stream considers a stable current boarded by the troposphere layer near the Hadley cell derived by angular momentum

The subtropical jet stream axis is located at 300 hpa level, and it has higher velocity over Africa and Asia near ridges, and lower velocity recorded near troughs [5].

The jet stream enhances the subtropical pressure systems over the surface because it formed on the lower side of the Hadley cell [6].

The subtropical jet stream influence distribution of ozone and lead to a higher gradient, so the jet stream location and upper fronts can be determined by ozone distribution, and the existence of the jet stream is directly linked to the existence of tight latitudinal temperature gradients [7].

MATERIALS AND METHODS

This study aims to understand the behavior of subtropical jet stream in summer for the Middle East and the relation between the jet stream and hot waves that pass over Baghdad city, the study depends on an analysis of meteorological maps over (300 hPa) because it is clearly shown in this level by using it as a pathway inside the atmosphere.

So the meteorological maps obtained from (the University of Wyoming) provide meteorological maps showing the (SJS) path as well as the values of variables such as temperature, dew point, pressure, and wind speed because the study attempts to correlate hot waves over Baghdad surface with subtropical jet stream, so the real data of Baghdad surface temperature was obtained from an automatic weather station that located over the atmospheric science building in side Mustansiriyah university in Baghdad city, and the study aimed to focuses on a case study extended from (16-7-2021) to (29-7-2021) to show the behavior of subtropical jet stream in summer and its correlation with Baghdad surface temperature, and the final table of collected data about these variables are shown in

Table 1. The study covers a wide region including the middle east from (25)^o to (75)^o longitude and from (5)^o to (45)^o of latitude [8], this covers the region of the subtropical jet stream as well as the region of Iraq to correlate between Iraq surface temperature in summer and jet stream passing in the same time, see Figure 1 which show the study region as well as the passing path of the subtropical jet stream and the focusing region that the study focusing on it [9].

Table 1. meteorological variables of the study interest.

Day	Temperature over (300hpa)	Dew point over (300hpa)	Wind speed over (300hpa)	Iraq surface temperature
16/7/2021	-37	15	20	44.5
17/7/2021	-36	16	15	46.8
18/7/2021	-37	12	40	48.4
19/7/2021	-32	17	18	48.2
20/7/2021	-28	20	80	42.9
21/7/2021	-27	21	80	42.1
22/7/2021	-28	18	50	44.9
23/7/2021	-27	17	75	46.4
24/7/2021	-30	19	70	45.9
25/7/2021	-27	4	80	45.9
26/7/2021	-36	19	50	45.1
27/7/2021	-35	3	50	46
28/7/2021	-37	1	50	46.1
29/7/2021	-37	16	20	44.7

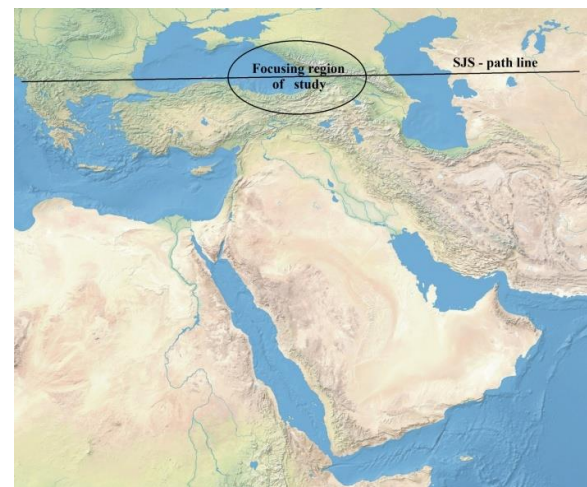


Figure 1. Middle east map showing the path way of jet stream and the focusing region of study [9].

Historical Study

Many studies cover the jet stream in general as well as a subtropical jet stream for many cases, for example, MA. shapero in (1990) study the upper front that correlated with a jet stream passing through the region of study depending on upgraded study balloons that consist of meteorological sensors [10], another study from Y. Bau and Q. you in (2019) studied the relation between jet stream and the snow cover depth in

the Tibetan plateau (from Nov. to Apr. months) for the period from (1979) to (2014) depending on satellite data and European center for medium range and weather forecasting, the result showed that there was a high correlation between the snow cover and the jet stream because of upper cold air advection existence [11]. N. Nakamura (2018) studied the meandering of the jet stream and the flow of wind that can be blocked causing heat wave over the area and this depend on the topography which causes variations in climate conditions [12].

RESULTS AND DISCUSSION

After analyzing meteorological maps over (300 hpa) level, the result showed that the wind speed reaches its maximum value when the jet stream passes the area of study inside the core of the jet stream, and this high velocity of wind is still on its values after two days and this shown on Figure 2 and Figure 3.

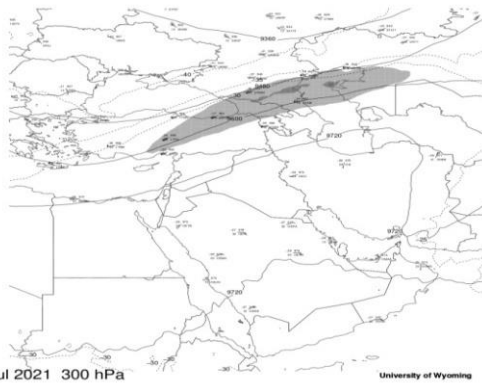


Figure 2. Subtropical jet stream passing the study zone with higher velocity on its core.

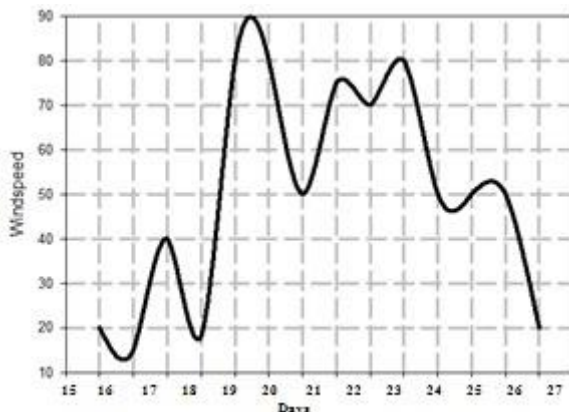


Figure 3. Variation of wind speed while the (SJS) is passing the zone.

For temperature variation, the study shows that it becomes higher than its averages when the subtropical jet stream pass, where it increased from approximately (-37) °C to become near (-27) °C and then become lower with the ending time of the jet stream, see Figure 4 before jet stream pass and Figure 5 after the pass of the jet stream over the same area to show the difference in temperature between them inside the subtropical jet stream passing line. Also, Figure 6 shows the variation in temperature for the period from (16-7-2021) to (29-7-2021) to understand the temperature behavior, but in general, the starting edge of the jet stream always records lower temperature than its averages, and then it becomes higher to become lower too while the jet stream across the path.

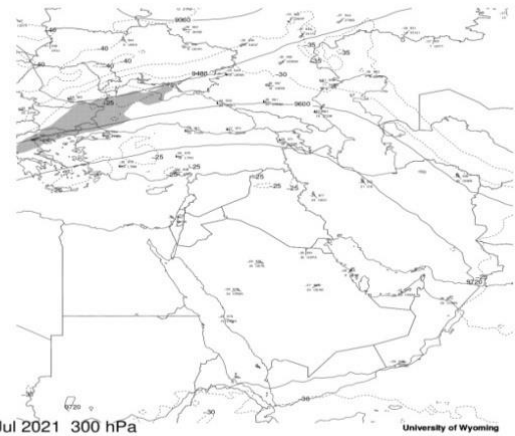


Figure 4. Two days before the (SJS) passing the zone.

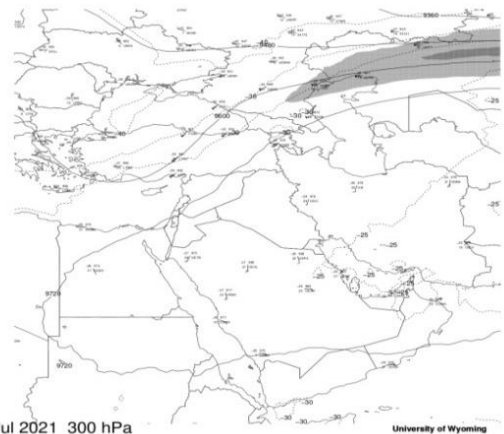


Figure 5. Two days after the (SJS) passing the zone.

For the dew point as shown on Figure 7 there was unstable fluctuation on its values but it records lowest value of the ending edge of jet stream by reaching (3) °C, so it has decreasing trend with time.

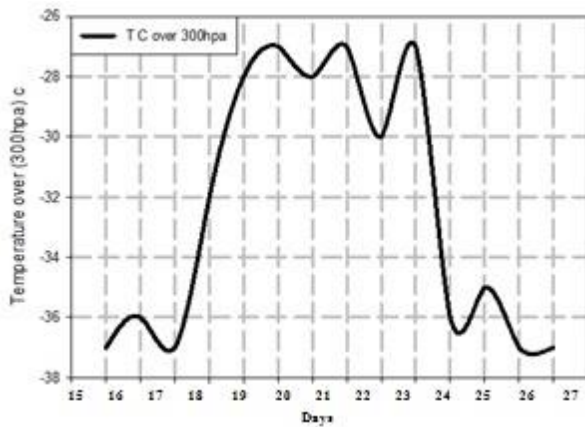


Figure 6. Variation of temperature while the (SJS) is passing the zone.

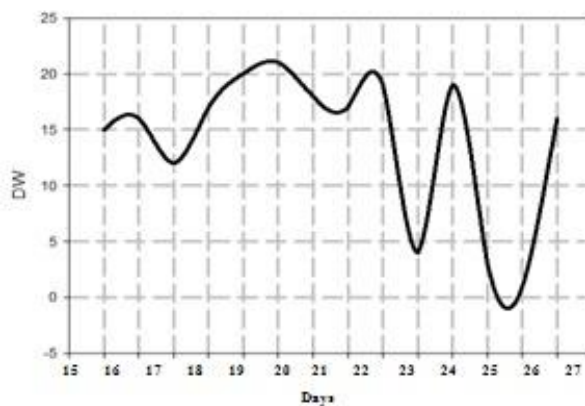


Figure 7. Variation of dew point while the (SJS) is passing the zone.

For Iraq, the study shows that the (300) hpa level record a stable high-pressure area which means that there is low pressure on the surface, and by focusing on Baghdad's surface temperature the study reached to that the higher value of temperature correlated with the starting of the subtropical jet stream in the north of Iraq and then it remains on its values over (45) °C after the crossing of the subtropical jet stream, see Figures 8.

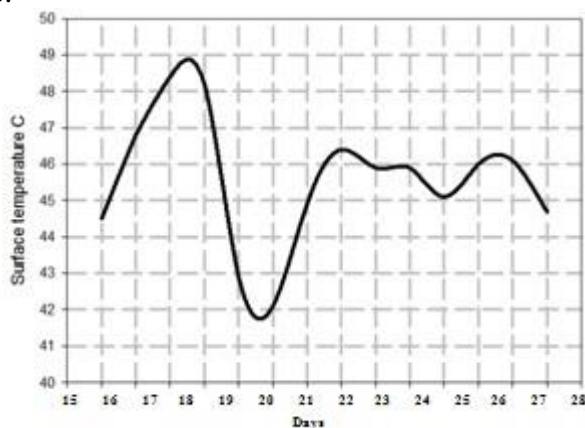


Figure 8. Baghdad surface temperature fluctuations while the (SJS) passing the zone.

for the pressure values the study showed that higher ranges recorded with the days of jet stream passing corresponded with the days (19,20 and 21) of July (2021).

CONCLUSIONS

The sub-tropical jet stream is widely correlated with the behavior of pressure systems in summer, and it corresponds with the increase of temperature degrees inside the jet stream path.

Also, the sub-tropical jet stream has a wind velocity reaches about (80 m/s), and the study showed that the higher temperature recorded on Baghdad surface was before the sub-tropical jet stream passed in its path and the temperature ranges become lower to about (45) °C, and the pressure system over Iraq on (300) hpa recorded the highest value while the tropical jet stream is passing on its path.

Disclosure and conflict of interest: The authors declare that they have no conflicts of interest.

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