مجلة كلية التربية للعلوم الصرفة - جامعة ذي قار
المجلد ٨، العدد ٢، حزيران ٢٠١٨
Website: jceps.utq.edu.iq Email: jceps@eps.utq.edu.iq

Analysis of seasonal pressure levels over middle east using ECMWF data

Omar Laith Khaleed

Omar.atmsc@uomostansiriyah.edu.iq

Al-Mustansiryah University / college of science / department of Atmospheric sciences

Abstract

The pressure levels has a wide effects on air motion in the Atmosphere , and it is considered as the main factor for the general circulation model (GCM) . this variable has multiple relationship with other meteorological variables so that it is very important in forecasting way . The methodology proposed and adopted in this work is based on one seasonal ensemble model which is the (ERA-15) model from (European Centre for Medium Range Weather Forecasting) (ECMWF) , and the given data extended for (14) years and it's from (1979) to (1992) for the middle east region and two levels (500hpa) (700hpa) . the data transformed to integrated seasonal ensemble in order to show the effect of seasonal change .The result showed on analysis of pressure levels height for each season for the two levels of the study that there are regions with relatively fixed pressure levels values on summer like Saudi Arabia and Arabian Peninsula in about (٥٨٠٠٠) $(m/s)^2$ while we find this behavior is minimum on winter seasons , and the results shows that the pressure levels value reach its maximum in the south of middle east in about (٥٧٦٠٠) $(m/s)^2$ while it reach its minimum value in north of this location in about (٥٤٢٠٠) $(m/s)^2$. and the gradient of line in (700hpa) level always greater as compared with the gradient of line in (500hpa) level .

Keywords: Analysis, seasonal pressure, middle east

Journal of College of Education for Pure Sciences
Volume 8, Number 2, June 2018
Website: jceps.utq.edu.iq Email: jceps@eps.utq.edu.iq

Analysis of seasonal pressure levels over middle east using ECMWF data

Omar Laith Khaleed
Omar.atmsc@uomostansiriyah.edu.iq
Al-Mustansiryah University / college of science / department of Atmospheric sciences

الخلاصة

يتميز الضغط بامتلاكه تاثيرات واسعة على حركة الهواء في الغلاف الجوي ، كما انه يعتبر من العوامل الرئيسية في حركة نموذج الدورة العامة للرياح (GCM) ، اذ يمتلك هذا المتغير علاقات متعددة مع المتغيرات الانوائية الاخرى مما يجعله فعالا من ناحية التنبؤ بشكل كبير ، ان الطرق المعتمدة في هذ العمل تعتمد على مجموعة فصلية متكاملة لنموذج (ERA-15) المأخوذة من المركز الاوربي للتنبؤات المتوسطة المدى للطقس (ECMWF) والبيانات المستخدمة في الدراسة هي لـ (١٤) سنة تمتد من عام (١٩٧٩) الى (١٩٩٢) لمنطقة الشرق الاوسط و للمستويين الضغطيين (700Hpa) و (500Hpa) حيث تم تحويل البيانات الى مجاميع قصلية متكاملة من اجل اظهار تأثيرات التغير الفصلي ، اظهرت النتائج بعد تحليل ارتفاعات المستويات الضغطية لكل فصل و لمستويي الدراسة ان هناك مواقع ذات قيم ارتفاعات ضغطية ثابتة نوعا ما خلال فصل الصيف كما هو ملاحظ فوق الاراضي السعودية وشبه الجزيرة العربية و تساوي $(58000\ (m/s)^2)$ في حين نجد ان هذا السلوك يكون طفيفا خلال فصول الشتاء ، كما اظهرت النتائج ان قيم ارتفاعات المستويات الغطية تصل الى اعلى قيمة لها في جنوب منطقة الشرق الاوسط اذ تساوي $(57600\ (m/s)^2)$ بيمنا تكون في ادنى مستوياتها شمال المنطقة لتصل الى $(54200(m/s)^2)$ ، كما وجد ان انحدار خطوط المستويات الضغطية قس مستوى (700Hpa) تكون دائما اقل من انحدارها في مستوى (500Hpa) .

الكلمات المفتاحية:تحليل,الضغط الموسمي,الشرق الأوسط

Introduction :

Each point in the atmosphere has an pressure value of its own (Ø) , so the surface where the pressure values are equal is a surface along its length. All objects with the same mass have the same energy (ω) values [1].

ω = MØ -------------------------- 1

M : Is the mass of the body.

Geopotential Height is defined as the height required to reach a certain level of pressure from a specific point on the surface of the earth, so each point has its own high rise, and since the earth is different height, sea level is taken to that height. The initial and simple belief suggests that the level of pressure is constant. For example, we take the level of (700hpa) for the purpose of illustration and say that the height of this level is (3200 m), but this value is the amount of the average, that is the average height of this level , And in order to reach the value of the rise of the force of the same level, we must understand that it represents the height of a certain point and specified that if we want to measure the pressure by the barometer device, we will find the value of (700hpa). In this sense it is also possible to clarify that it is possible to find a point where the pressure is (500hpa) and at a height of (5500 m) , for example, while a point away from any distance in which the value of the pressure (500hpa) also, but the height is (5200) That their height (Geopotential Height) is less, and may find the same pressure value at a level higher than this level as shown in Figure (1) [2].

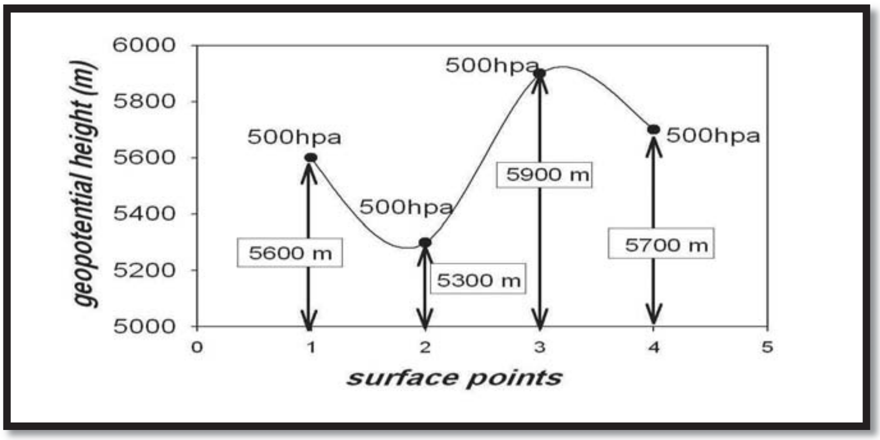


Figure 1: multiple geopotential heights Values (500hpa).

Geopotential height has a wide relationship with temperature, humidity, wind speed, and the rise and fall of depressions and highlands. It also affects many elements and basic atmospheric patterns as well as geostrophic winds. Hence, researchers began to pay attention to this variable because of its great importance in the fields of agricultural, industrial and economic life, and the world has recently undergone extensive research by introducing this variable within numerical modeling programs of the atmosphere. [3]

The scientific development in the field of computers has been accompanied by a major development in the data systems, which resulted in the emergence of specialized research centers because they represent the fundamental of medium and long-term studies, and the emergence of specialized predictive centers to study the state of the atmosphere and its factors, as such centers provide important data can Through which scientific studies are more specialized to know the behavior of the climate system and the meteorological factors that depend on , so the study of altitudes have a significant impact on the system of the movement of the general circulation models in the atmosphere on a large scale (GCM). [4]

The study was based on data obtained from the European Forecasting Center (ECMWF), specifically the ERA-15 model taken from (Ecmwf) Re Analyzes, which was converted to quarterly and four-season data. Winter (December, January , and February) (DJF). Summer (June, July and August) (JJA). spring (March, April and May) (MAM) and for the Autumn season (September, November and November) (SON). The study used the two main levels (500hpa and 700hpa) as levels of prediction as they fall within the troposphere and have a clear effect on atmospheric disturbances [5]. They provide an integrated picture of the atmosphere in general and are often used in Advanced air stations. The data used are from 1979 to 1992 and is sufficient to test the seasonal prediction in order to show the apparent behavior of the geopotential heights and calculate the seasonal averages for selected periods of time.

Results and discussion

the general patterns of natural growth (Geopotential Height) were studied based on the analyzed maps resulting from taking the quarterly averages for each chapter from the ERA-15 model. The Middle East region was also chosen north of the equator due to its large importance Resulting from its predictive geographical location, as well as its appropriate area, longitude 20^0 to 60^0 and latitude 10^0 to 40^0[6]. The result maps are analyzed in the Contour lines and in intervals of $(200\ m/s)^2$. it has been shown that the geopotential height have different behavior with the seasonal change in terms of the behavior of the geopotential equal lines . as the analysis in terms of integrity or curves shows that their behavior is different with different seasons, as the winter can be distinguished from the summer, The curves in winter tend to have a few curvature and horizontal straightness parallel to latitude lines and do not have large curves such as summers, which of course makes the areas on the same latitude almost have their own height values similar or somewhat similar. Figure (2-a) shows this behavior for the year 1982, for example, from the ERA-15 model for the pressure level (hpa500) in the winter season, where it is increasingly divergent as we move towards the equator, This behavior is also approximated at the level of (700hpa) as in Figure (2-b) of the same previous model as before 1984, since they have semi-horizontal lines between them, but this behavior differs as we approach the equator at both levels, and that this behavior exists in all years Study without exception. In both shapes, the lines have similar and consistent curves over the regions of Iraq and the Red Sea.

In summer, contour lines tend to take clear, wide and almost closed curves, so they do not equal and do not converge horizontally due to those curves. This is the result of the presence of the dominant air systems in the region in summer, the centers are located almost above the middle of the Middle East, and can be determined between latitudes $(20)^0$ and $(30)^0$ north, which includes parts of the Arabian Peninsula and Saudi Arabia and expand horizontally to include parts And the size of this center varies with the change of years, but the indicators confirm that the regions of Saudi Arabia are often located in this center or close to it at (500hpa) level as shown in Figure (3-a) , which we find Where the value of the geopotential heights reaches its highest level and equal to $(58000\ m/s)^2$ above the center of study area in 1990. At (700hpa)level, this center is expanded to include wider parts in the Middle East, but it turns out that this center is turning left out of the study area as seen in Figure (3-b) in 1983, The left end of the latitude is approximately $(20)^0$, where the highest geopotential value covers large areas $(31000\ m\ /\ s)^2$.

In spring and autumn, the behavior of the geopotential heights lines is very similar because they are weak transition periods with close behavior. However, the spring season is similar to winter in terms of parallel lines, slopes and distance. For autumn, it is similar to the summer season in terms of the presence of curves and the spacing of the lines, although this resemblance is somewhat slight, figure (4-a) for the spring and figure (4-b) for autumn (1982) at (500hpa) level . Perhaps the reason is that the autumn seasons have their chronological sequence immediately after the summer months, making the summer seasons leave their traces on the autumn seasons and give them a similar behavior, albeit less, and on the contrary in the spring seasons that contain the effects of winter because of their chronological sequence However, in general, it is somewhat difficult to distinguish between the two seasons easily based on the behavior of lines.

It is noted that the values of geopotential heights at (500hpa) and (700hpa) levels in the winter are the lowest values in the northern regions of the Middle East, but these values are rising as we headed south of the region, towards the equator, The atmospheric layers in the tropics are higher than in the polar regions [7], where it can be shown that the rises of these layers from the pole to the equator, which generates gradually increasing values of the altitudes towards the equator, making these levels take values lower than their zones North of the While the Middle East is higher than in the southern regions. Figure (2-a) shows the change in the values of the lines in the winter from the highest values for (500hpa) level, where the value of the geopotential heights increases from $(54200\ m/s)^2$ to $(57600\ m/s)^2$ north , Figure (2-b) for (700hpa) levels is shown the gradient from $(29400\ m/s)^2$ to the highest value in the south of the region and equal to $(30800\ m/s)^2$, but in the summer the decline of values gradually towards The equator is present but at a lower rate due to the bending of the lines resulting from the control of the air systems to mediate the region over Saudi Arabia and larger parts of the Arabian Peninsula as in Figure (3-a) where it is up to $(58000\ m/s)^2$ Expands to Parts of surrounding areas were included as in Figure (2-b).

When comparing the distance ratios between (500hpa) and (700hpa), we find that these lines are highly spaced at (700hpa) while they are less divergent at (500hpa) in Figure (2-a) is more similar than in the figure (2-b), which represents the (700hpa) level for the same season . The reason is due to temperature changes with vertical height, as the temperature naturally decreases With the increase of vertical height from the surface [8], and since the (700hpa) level is located at the rate of (3200 m) in height , which is less than the rate of (500hpa) height The temperature at (700hpa) is much higher than (500hpa) , so the lines will be more divergent due to the expansion of the air molecules at (500hpa) level . Whose molecules suffer from shrinkage due to low temperatures, which results in closer proximity to the geopotential heights lines at higher levels compared to lower levels.

The behavior of the contour lines indicates an important indication of the extent of Convergence and divergence and therefore the different characteristics of the atmosphere of that region and with the different time periods, so it was found that these lines at (500hpa) and (700hpa) in the summer tend to diverge from each other significantly , As in Figure (3-a , 3-b) , where the slope of the lines are small. It can be traced by dividing the number of the geopotential heights lines by the number of latitudes $(\Delta\mathbb{Z}/\Delta\emptyset)$ However, this behavior is quite different in the winter, as these lines are more closely related to their rates, and their regression is greater in comparison to the summers. This behavior is present at both levels, as in Figure (2-a , 2-b), Where we find that the distance between those lines in summer can reach twice the value in winter. The reason for this is that the temperatures rates in summer are higher than in winter at the northern hemisphere, and that increase in temperature in summer leads to the expansion of atmospheric air , including the troposphere containing the levels of study, which have a high relative density As compared to the rest of the layers [9], and this expansion leads to the spacing of the contour lines of the geopotential heights of each levels of pressure. On the contrary, in the winter, the atmosphere suffers from a reduction in its particles and then the opposite effect of the summer season to the greatest value possible due to shrinkage of the atmosphere because of lowest temperatures in winter. When we associate this behavior with the latitude change, we find that these lines are increasingly divergent as we move towards the equator in the region while tend to converge northward toward the pole. It is also dependent on temperature change as it increases toward the equator and decreases in the direction of the pole in the study area.

It is also noted that these lines have relatively similar and moderate spacing values in the spring and autumn seasons, ie, they are intermediate between winter and summer. Therefore, in some cases, it is difficult to distinguish the spring seasons from autumn. Figure (4-a , 4-b) shows the similarity of geopotential heights equal lines between the spring and autumn respectively, as well as the flow of different dimensions. Its behavior in terms of divergence and convergence is relatively similar, and its slopes are somewhat similar. This is because spring temperatures are close to their levels in autumn seasons, which are at their average rates between winter and summer, And autumn are weak transition seasons with little change and similar behavior.

Conclusions

The geopotential heights lines of both levels in the winter tend to be close, with a few curvature and horizontal straightness with high slopes parallel to the latitudes. They do not have large curves such as summers where the lines tend to diverge and form clear and almost closed curves in the middle of the Middle East, Saudi Arabia and parts of the Arabian Peninsula. The geopotential heights lines in the specified seasons show that they are more divergent and less steep at (700hpa) compared to (500hpa). We find that there is a convergence in the behavior of geopotential heights lines between the spring and autumn to a large extent, despite the fact that the transitional seasons are weak and moderate values between the winter and summer. The height values are based on latitude and are clearly different between winter and summer. The values of (500hpa) and (700hpa) in the northern regions of the study area are low and have large slopes, for example in winter (1982) the (500hpa) is equal to (54200 $m/s)^2$ in the north of the region while increasing south to (57600 $m/s)^2$ for the same season. The values of geopotential heights in summer are more than the rates compared to the winters above the specific point, where it was found that the values above Baghdad, for example, the (500hpa) level is equal to (5550 $m/s)^2$ in the winter while increasing in summer to approximately (5780 $m/s)^2$.

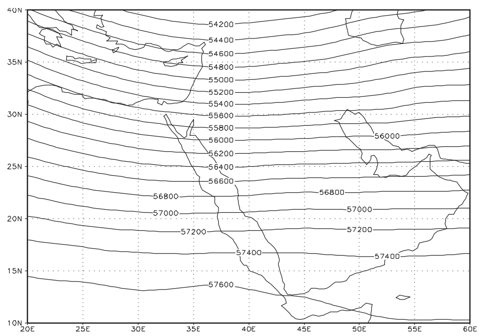
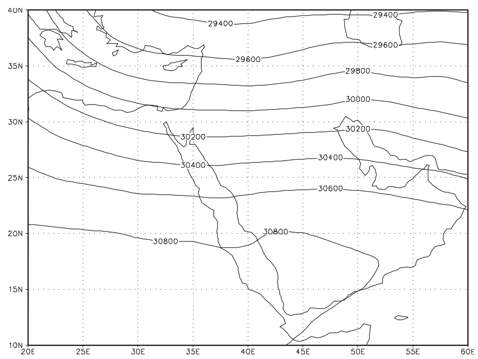
(a) Geop. 500 winter (DJF) 198٢	(b) Geop. ٧00 winter (DJF) 198٤
	

Figure 2: Equivalent lines of the geopotential heights of the two levels (500hpa) and (700hpa) (winter) from the ERA-15 model

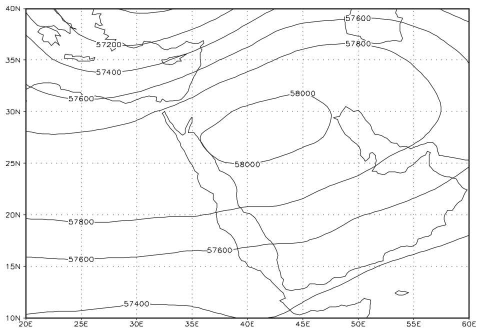
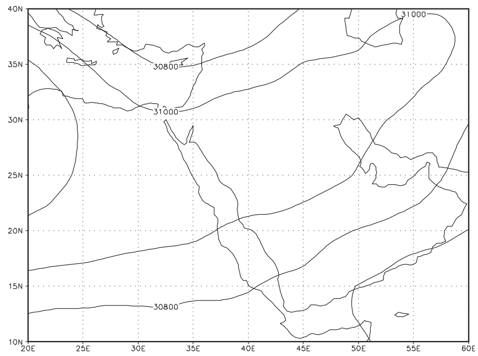
(a) Geop. 500 summer (JJA) 19٩0	(b) Geop. ٧00 summer (JJA) 198٣
	

Figure 3: Equivalent lines of the voltage heights of the two levels (500hpa) and (700hpa) (summer) from the ERA-15 model

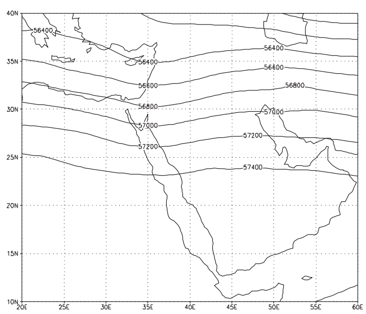
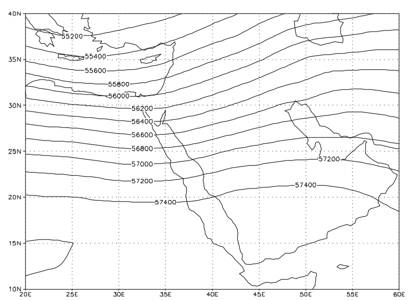
(a) Geop. 500 spring (MAM) 1982	(b)Geop. 500 autumn (SON) 1982
	

Figure 3: Equivalent lines of the voltage heights of the two levels (500hpa) and (700hpa) (spring and autumn) from the ERA-15 model

References

1- Horace , Robret , B. , 1959, : "General Meteorology'', Forth edition , M.C. Graw-Hill Press , p460.
2- John , M. , Peter , V. , 2005,: "Atmospheric science" , Second edition, University of Washington , Washington , D. C. , PP. 483 .
3- Jacobs , R. , E. , 1968 , : "A comparison of Geopotential VS Wind input for A diagnostic Numerical Model ", Master's Thesis , US. National Technical information service .
4- Yang , X. , Q. , Anderson , J. , L. , Stern ,W. , F. , 1998 , : "Reproducible Forced modes in AGCM ensemble integration and potential predictability of atmosphere seasonal variation in the extratropics", Journal of Climate , vol. 11 , PP. 2942-1959 .
5- Maurice , L. , Blackmon , 1976 , : "A climatological spectral study of the 500 mb geopotential height of the northern hemisphere", Journal of Atmospheric Science , vol. 33 , 1607-812 .
6- Middleton , N. , J. , 1986 , : "Dust Storm in the Middle East", Journal of arid environments, vol. 10 ,PP. 83-96.
7- Holon , James , R. , 2004 , : "An introduction to Dynamic Meteorology", fourth edition , Elsevier Academic Press, London ,UK, pp. 535 .
8- John , M. , Peter , V. , 2005,: "Atmospheric science" , Second edition, University of Washington , Washington , D. C. , PP. 483 .
9- Horace , Robret , B. , 1959, : "General Meteorology'', Forth edition , M.C. Graw-Hill Press , p460.