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Study of Some Patterns for Severe Rainfalls over Iraq

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ABSTRACT

Study of rain received particularly great importance in the areas described as semi-arid, which is on the other hand are not well prepared for the drainage of rain that may turned into flash floods. The pressure systems, especially those passing through the country in the winter rainy season and spring also autumn have a role in determining the amount of rainfall falling in the region In addition to climate change and its effects in terms of climate cycles and climate extremes and thus required determine the size of rainfall Whether it is beneficial or harmful. In this study to determine of heavy rainfalls, two important cases of heavy rainfalls were studied in 24, Dec, 2016 and 24, Nov, 2018, which exceeded 50 mm on the Iraq, from one country to another in this account , rainfalls rate, divider from the World Meteorological Organization (WMO) in which the rain intensity is determined according to the schedule and limits (light precipitation I≤2 mm / hour), (moderate precipitation 2<I≤10 mm / Hour), (heavy precipitation 10 <I≤50 mm / hour), (torrential precipitation I> 50 mm / hour). Each case was Analyzed and visualized by using the data analysis and display system (GrADS) The data were obtained from Tropical Rainfall Measuring Mission (TRMM). Show maps results of the first case in (24 December, 2016) in the northeastern region, the central region and the western region of the country the abundant rain condition through maps of rainfall rates on these areas as well as by maps of mean sea level pressure and dense cloud cover, maps showed a decrease the temperature accompanying the low pressure also streamlines, geopotential height, relative vorticity show this. And show the vertical velocity (omega), relative humidity, geopotential height, relative vorticity, and show support of air decline in terms of streamlines, relative humidity, geopotential height and relative vorticity over the country. Maps 700 hPa the vertical velocity (omega), relative humidity, geopotential height and relative vorticity, maps 500 hPa, results of second case, (24 November, 2018) that occurred in the northeastern and eastern part and southeastern part of the country, also appear clear through maps of falling rainfall rates, as well as maps of sea level pressure and the dense cloud cover accompanying the heavy rain situation. maps 850 hPa it shows the low temperature accompanying the atmospheric decline, also streamlines, geopotential height and relative vorticity also maps 700 hPa and 500 hPa lik first case, in differential patterns all of this shows clear support for the atmospheric decline in terms of streamlines, relative humidity, geopotential height, and relative vorticity, and explain the causes of heavy rain situation over Iraq.

KEYWORDS: Severe rainfall, GrADS, Relative vorticity, Geopotential height.

الخلاصة

تلقى دراسة المطر أهمية كبيرة بشكل خاص في المناطق الموصوفة على أنها شبه قاحلة، من ناحية أخرى ليست مستعدة بشكل جيد لتصريف الأمطار التي قد تتحول إلى فيضانات سريعة. لأنظمة الضغط ، خاصة تلك التي تمر عبر البلاد في فصل الشتاء الممطر والربيع الخريف أيضًا دور في تحديد كمية الأمطار المتساقطة في المنطقة بالإضافة إلى تغير المناخ وآثاره من حيث الدورات المناخية والظواهر المناخية المتطرفة وبالتالي مطلوب تحديد حجم الأمطار سواء كانت مفيدة أو ضارة. في هذه الدراسة لتحديد هطول الأمطار الغزيرة، تمت دراسة حالتين مهمتين لهطول الأمطار الغزيرة في 24 ، ديسمبر ، 2016 و 24 ، نوفمبر ، 2018 ، والتي تجاوزت 50 ملم على العراق، ومن بلد إلى آخر في هذا الحساب، معدل هطول الأمطار مقسم من المنظمة العالمية للأرصاد الجوية (WMO) يتم فيه تحديد كثافة الأمطار وفقًا للجدول الزمني والحدود (هطول خفيف I≤2 ملم / ساعة)، (هطول معتدل 2 I≤10> ملم / ساعة)، (هطول كثيف 10

50≤I>ملم / ساعة)، (هطول أمطار غزيرة 50 <I ملم / ساعة). تم تحليل كل حالة وتصورها باستخدام نظام تحليل البيانات وعرضها (GrADS) وتم الحصول على البيانات من بعثة قياس هطول الأمطار الاستوائية .(TRMM) عرض نتائج خرائط الحالة الأولى في (24 ديسمبر 2016) في المنطقة الشمالية الشرقية والمنطقة الوسطى والمنطقة الغربية من البلاد حالة الأمطار الغزيرة ومن خلال خرائط معدلات هطول الأمطار على هذه المناطق وكذلك من خلال خرائط الضغط عند مستوى سطح البحر وغطاء السحابة الكثيفة، أظهرت الخرائط انخفاضًا في درجة الحرارة المصاحبة للضغط المنخفض، كما يبين الارتفاع الجغرافي، والدوامة النسبية ايضا تظهر ذلك. وتظهر السرعة الرأسية (أوميغا) ، والرطوبة النسبية، والارتفاع الجغرافي، والدوامة النسبية، وتظهر دعمًا لانخفاض الهواء من حيث الرطوبة النسبية والارتفاع الجغرافي والدوامة النسبية فوق البلاد. خرائط 700 hPa السرعة العمودية (أوميغا)، الرطوبة النسبية، الارتفاع الجغرافي والتدويم النسبي، وكذلك خرائط 500hPa . نتائج الحالة الثانية بتاريخ (24 نوفمبر ، 2018) والتي حدثت في الجزء الشمالي الشرقي والشرقي والجزء الجنوبي الشرقي من البلاد، أيضًا تظهر بوضوح من خلال خرائط انخفاض معدلات هطول الأمطار، وكذلك خرائط الضغط عند مستوى سطح البحر والغطاء السحابي الكثيف المصاحب لحالة الأمطار الغزيرة. وخرائط 850 hPa تُظهر درجة الحرارة المنخفضة المصاحبة لانخفاض الغلاف الجوي، كما يبدو والارتفاع الجغرافي والتدويم النسبي أيضًا خرائط 700 hPa و 500 hPa مثل الحالة الأولى من ناحية الانماط الموجودة مع اختلاف الشدة، في أنماط متباينة كل هذا يظهر دعمًا واضحًا للانخفاض الجوي من حيث الانسيابات، الرطوبة النسبية، الارتفاع الجهدي، والتدويم النسبي، ويبين أسباب هطول الأمطار الغزيرة فوق العراق.

INTRODUCTION

Rain is an important resource in the general hydrological cycle on the surface of the Earth and sustaining life on the Earth's surface for living things. The study appeared on the effect of climate changes widely through successive climatic cycles on the earth surface in the world, droughts, and rainy seasons, mechanism dealing with these climate changes through predictive studies of these regions which give a clear vision and the economic benefits gained for these countries through preserving lives and property, benefiting from it in the agricultural aspect, developing and improving it The future of countries through studying work environment. Typically, the mid-latitude climate, geographic divisions generally lie between the polar edge of sub-equatorial high pressure systems (about 35° N and S line), and the polar rotation (approximately 60° N and S). From years, the mid-latitude climate is referred to as a reference to the temperate zone. while the area contains some of the most extreme weather conditions. In the Northern Hemisphere, mid-latitude climates may have some high continental scales, and are primarily a sign of severe seasonal events [1]. The Middle East is the region with the highest water shortage in the world [2]. The patterns of precipitation of climatic region in the Mediterranean Sea change greatly in terms of time, location and amount of precipitation in terms of its quantity and the period of specified events [3]. The aim of studying this research is to identify some patterns that lead to heavy precipitation over the country in order to avoid the dangers of heavy rains and take advantage in return of heavy rains above average for the purposes of storage, agriculture and other aspects of life. There are several researchers, studies and searches about rainfall severity and Its effect such as: Al-Nassar (2019) [4] investigated the rainfall concerning the monsoon cutoff low through two scopes: local and global to show their different impacts on Baghdad during the period (2005-2016). Shatha I. Jafaar, Jasim H. Khadum (2019) [5] Used the methods of dynamics analysis of rainfall in Iraq for four locations. They concluded that the main causes of rainstorms in Iraq are the Mediterranean low, the Sudan low that passes over the Red Sea, and some other cases with merged systems initiated by turbulence. Al-Nassar (2018) [6] studied the synoptic effects of the various weather systems on the amount of precipitation on a spatial basis for different regions in Iraq by using ERA-Interim dataset. Salman, A. S (2017) [7] studying non-directional method for the highest stages of daily rainfall in Iraq, which included estimating daily rainfall data for a long period (1965-2015), the study showed a decrease in rainfall, including heavy rains during the year. Rosta et al, (2017) [8] studied the spatial pattern of rare instances of heavy rainfall thresholds and differences in the ten-temporal spatial position at this road in the northwestern part of Iran. The conclusions showed a decrease in the trend in the limits of the heavy precipitation in the last decades. Deng et al., (2015) [9] used weather forecast and a detection model to simulate the conditions of a rainstorm formed for floods, its properties over Saudi Arabia. Starting from the description of the primary synoptic characteristics, Vries et al (2013) [10] studied the transformation of

moisture from the Arabian Sea and the Red Sea resulting from the dynamic processes of the active Red Sea, which led to heavy rains over the Middle East.

MATERIALS AND METHODOLOGIES

We worked on archived torrential rain events and were included in the (GrADS) program to arrive at the results of analyzing these heavy rain conditions. The information is also from task of Tropical rainfall measuring mission (TRMM), and through the results that emerged from the program (GrADS) in the form of maps similar to Synoptic maps, the torrential rain situation over the country was analyzed by explaining in two selected cases and the amount of rain precipitation was estimated by referring to the World Meteorology Organization estimate, which considered that rain precipitation exceeding (50 mm / hour) is heavy precipitation and also reaches flooding, this was clarified by explaining maps and the correlation between variables and weather elements, the depth of the low air pressure system and the rate of rain precipitation in both cases.

RESULTS AND DISCUSSION

Severe Rainfalls Case of 24, Dec, 2016

Shows Heavy rainfall in (24 December 2016), the state of rain according to figure 1a at a rainfall rate between (80-100 mm / day) in the northeastern part and the central and western regions of the country (Khanaqin, Sulaimaniyah, Ramadi, Diyala, Baghdad and Karbala) is rainy condition, which certainly occurred under atmospheric conditions of instability in the atmosphere, which led to this rate of rain. Figure 1b shows the surface weather chart and the total cloud cover which is also a sign of a decrease in air pressure. Figure 1c at the pressure level 850 hPa shows the temperature and streamlines and the relative humidity, in relation the temperature it should be relatively low in the temperature and it appears clear in the region. In addition, the movement of the line is extending upward from the southern direction. It represents the movement of the lines in the direction of atmospheric regressions (low atmospheric pressure), relative humidity confined between (80-100%) and clear feeding from the Mediterranean and Red Sea. Figure 1d show geopotential height contours and relative vorticity at 850 hPa, are a possible geopotential increase relatively and low pressure in all parts of the country and the mentioned area confined by value between (148 - 152 dam). As for the relative vorticity and confined between (0, -4 1e-5) It is also indicator of the shear activity and relative vorticity activity and it is an indicator of the low pressure activity. Figure 1e shows the vertical velocity and relative velocity, at the pressure level of 700 hPa, where the vertical velocity between value (-0.2, -0.4 Pa/s), and an indication of the activity of the low pressure area in the northeast, east and west of the country, the relative humidity between (80 -100%) is a clear indication of good nutrition to the low pressure, figure 1f shows us the geopotential height and the relative vorticity at Pressure level 700 hPa hows relatively low geopotential height lines in height (304-306 dam) which indicates the activity of the relatively to low pressure area above the country.

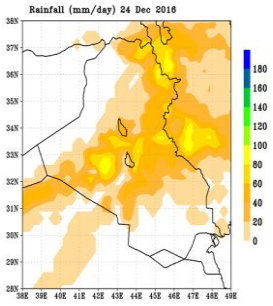

Fig.1a: Daily rainfall for 24 Dec 2016.

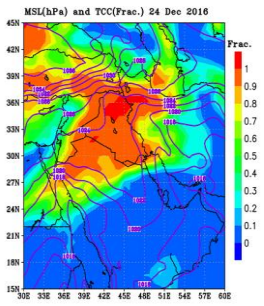

Fig.1b: Mean sea level pressure and total cloud cover for 24 Dec 2016.

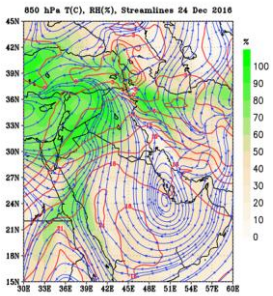

Fig.1c: 850 hPa temperature, streamlines and relative humidity for 24 Dec 2016.

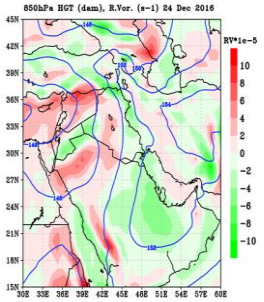

Fig.1d: 850 hPa geopotential height and relative vorticity for 24 Dec 2016.

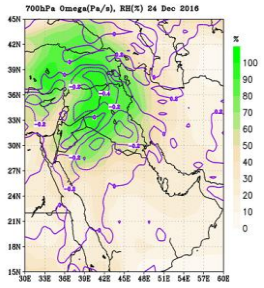

Fig.1e: 700 hPa vertical velocity and relative humidity for 24 Dec 2016.

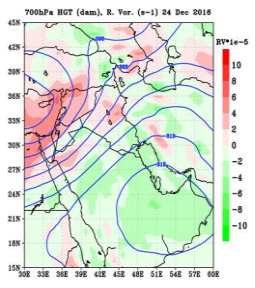

Fig.1f: 700 hPa geopotential height and relative vorticity for 24 Dec 2016.

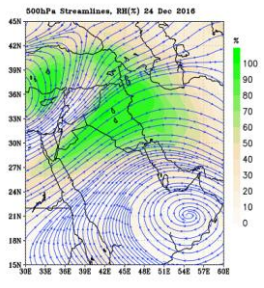

Fig.1g:500 hPa streamlines and relative humidity for 24 Dec 2016.

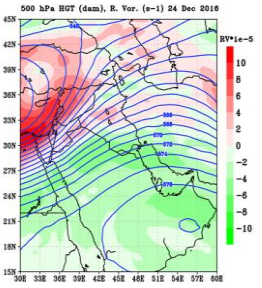

Fig.1h: 500 hPa geopotential height and relative vorticity for 24 Dec 2016.

Figure 1. Severe Rainfalls over Iraq in (24 Dec 2016).

Figure 1g show streamlines, the relative humidity of the pressure level is 500 hPa. and show the direction movement of streamlines for low pressure air direction, relative humidity between (80-100%) is an indication of good nutrition for the northeastern and central and western regions of the country and is a clear indication of increased rainfall in the region. Figure 1h show the geopotential height and relative vorticity at the pressure level 500 hPa, where we show the lines (558-564 dam) and the area between them it is a relative decrease. Altitude is an indication of a decrease in the atmospheric pressure and a decrease in temperature in the region. Relative vorticity between (2-6 $1e^{-5}$) is also an indication of the relative increase in the relative eddy shear and curvature is an indication of a decrease happened in the atmosphere in this region. It has been observed the studied patterns of pressure levels, in follow-up to the torrential rainy weather from sea level, 850, 700, 500 hPa, in which the average daily precipitation exceeds 50 mm / hour according to the World Meteorological Organization classification that there is correlation and support in the studied pressure levels through the availability of moisture Necessary for feeding, as well as the conditions of the cold layers for condensation at this time of the year, which usually when all kinds of clouds exist, indicate that there are thunderstorms so that negative values indicate that, as well as the clear trough in the 500 hPa map.

Severe Rainfalls case of 24, Nov, 2018

It shows the heavy rainfall, entitled (24 Nov 2018) and through Figure 2a illustrates heavy rainfall of the northeastern, the eastern parts and some southeastern parts of the country (Sulaymaniyah, Khanaqin, Diyala, Kut) to be affected by the heavy rain. Figure 2b shows the atmospheric pressure at sea level chart and the volume of dense cloud cover where it shows a decrease in the value of atmospheric pressure as well as a dense cloud cover at a rate of eight eights and for various low, medium and high altitudes which is a clear indication of a low atmospheric pressure zone. Figure 2c shows the temperature, streamlines and the relative humidity of the pressure level 850 hPa where appear temperature is a relative low temperature and for the streamlines movement of low air over the country resulting from the merger of two atmospheric lows from Mediterranean and Red Sea, as for relative humidity show relative humidity up to (80-100%) good feed of the atmospheric low rainfall heavy. Figure 2d shows the lines of geopotential height and relative vorticity of the pressure level 850 hPa up to (148 dam) which is relatively low for the signal the atmospheric low. As for the relative vorticity It is confined between (2-4 $1e^{-5}$) and relative vorticity suitable for activity of cyclonic movement in the low air. Figure 2e shows us vertical velocity and relative humidity at the pressure level of 700 hPa, where the value of vertical velocity confined between (-0.2, 0 Pa/s) clear activity of the upward vertical movement and represents activity in the system of atmospheric depression or low pressure either for relative humidity confined between (70-90%), clear activity shows good nutrition for the area and suitable for the formation of clouds and heavy rainfall. Figure 2f shows the geopotential height and the relative vorticity at the level of 700 hPa where the lines of geopotential height confined between (302-304 dam)clear decrease in geopotential height, it is evident by the geopotential height which is an indication of the presence of low pressure zone as well as That relative vorticity between (2,4 1e-5) is a

clear indicator to the relative vorticity activity represented by shear, curvature and increase in movement and support for the low air Compared to the surrounding areas. Figure 2g shows streamlines as well as the relative humidity at the pressure level 500 hPa, where we show lines streamlines relative humidity shows us the humidity available in the area between (60-70%) for atmospheric depression. Figure 2h shows the geopotential height and the relative vorticity at the level of 500 hPa where it shows us the decrease in the value of the lines of the altitude lines confined between (554-558 dam) to the presence of a region of low or atmospheric pressure zone Low, the relative vorticity between (2,6 1e-5) indicates clear activity in the value of relative vorticity represented by shear vorticity, curvature low pressure, height in value relative vorticity sign to activity low pressure and movement of air upward represented in rainfalls and reach to heavy rains. It has been observed the correlation of patterns accompanying the system of low atmospheric pressure through maps, through humid support and the diversity of dense clouds at different altitudes, as well as the value of negative vertical speed and low geopotential height and opportunities suitable for thunderstorms due to the time of the year between autumn and winter and the coolness of the relative air layers.

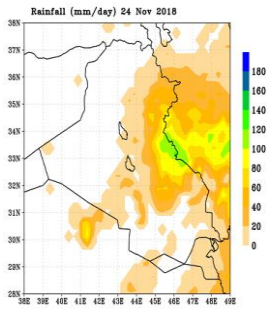

Fig.2a: Daily rainfall for 24 Nov 2018.

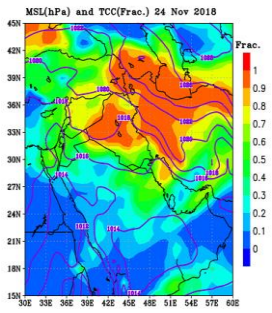

Fig.2b: Mean sea level pressure and total cloud cover for 24 Nov 2018.

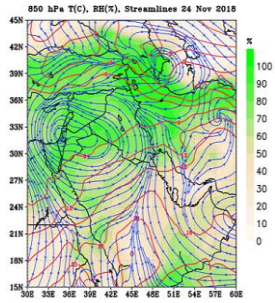

Fig.2c: 850 hPa temperature, streamlines and relative humidity for 24 Nov 2018.

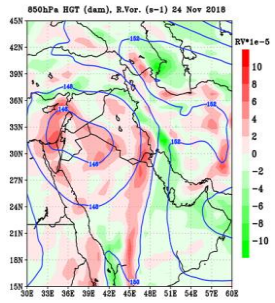

Fig.2d: 850 hPa geopotential height and relative vorticity for 24 Nov 2018.

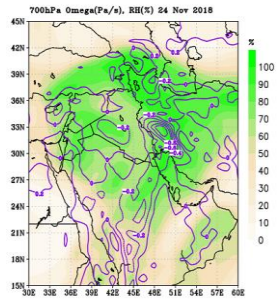

Fig.2e: 700 hPa vertical velocity and relative humidity for 24 Nov 2018.

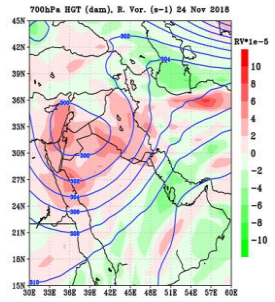

Fig.2f: 700 hPa geopotential height and relative vorticity for 24 Nov 2018.

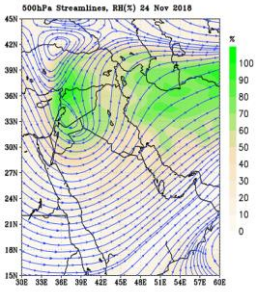

Fig.2g: 500 hPa streamlines and relative humidity for 24 Nov 2018.

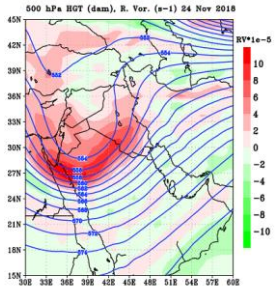

Fig.2h: 500 hPa geopotential height and relative vorticity for 24 Nov 2018.

Figure 2. Severe Rainfalls over Iraq in (24 Nov 2018).

CONCLUSIONS

The study identified, two important rain cases occurred over Iraq, and a number of important notes were concluded in this regard, heavy rain conditions were chosen to some different regions of the country and studied variety and increase information,

Among the patterns that have been identified for the purpose of predicting heavy rain over the country are: 1- The presence of concentric circles or closed circuits of isobaric lines, compressive values whose values decrease to within the air system. 2- The depressions of intermediate shows that pass through Iraq are mostly depressions of a pre occupational

frontal nature, that is, they consist of two hot and cold fronts accompanied by the types of clouds and precipitation accompanying them. 3- There are heavy rains of thundery character at the end of autumn and early winter, as well as spring rains that are prolific and thunderous due to the presence of heat, humidity and cold layer in the upper atmosphere, 4- Strong thermal slope is accompanied by cold or warm progress and there is a great opportunity to form clouds and rain, 5- Heavy rains on warm fronts are of a continuous and continuous nature for a long period of time leading to floods occurring in many cases, which are: A very clear sign, according to the movement of the air depression and the warm front, to anticipating heavy rains, and is usually accompanied by clouds of Nimbostratus. As for the cold front, it is of a scattered and severe rainy nature. The upper one will lead to certain expectations of heavy and thunderstorm rain due to the activity of the air depression and its depth and because of the crossing of the cold front that is of a heavy and thunderstorm nature and the clouds accompanying it are the clouds of Cumulonimbus if it happens that there is a hot fullness if the cold fullness of the air depression will also be accompanied by heavy rain, 6- The presence of negative values in the vertical velocity maps indicates that there is a type of upper separation, meaning the uplifting of the lower air and the formation of clouds. The more the negative value increases, the more it is a sign of severe overhead lifting and the formation of clouds.

REFERENCES

[1] Bridgman, H. A., & Oliver, J. E. (2014). *The global climate system: patterns, processes, and teleconnections*. Cambridge University Press. https://doi.org/10.1017/CBO97805 1181798.

[2] Klein Tank, A. M. G., & Können, G. P. (2003). Trends in indices of daily temperature and precipitation extremes in Europe, 1946–99. *Journal of climate*, *16*(22), 3665-3680. https://doi.org/10.1175/1520-0442(2003)016<3665:TIIODT> 2.0.CO;2.

[3] Brunetti, M., Colacino, M., Maugeri, M., & Nanni, T. (2001). Trends in the daily intensity of precipitation in Italy from 1951 to 1996. *International Journal of Climatology*, *21*(3), 299-316.

[4] Al-Nassar, A. R. (2018). "Dynamics of Cyclones and Precipitation over the Middle East". UPC, Departament de Física,.PhD. https://digital.csic.es/bitstream/10261/184787/1/Al_Nassar_Thesis_2018.pdf .

[5] Jafaar, S. I., & Kadhum, J. H. (2019). Dynamical Analysis of Severe Rain Events over Iraq. *Al-Mustansiriyah Journal of Science*, *30*(1), 15-22.Msc. doi: http://doi.org/10.23851/mjs.v30i1.586 .

[6] Al-Nassar, A. R. 2019. "Cut-off low systems over Iraq: Contribution to annual precipitation and synoptic analysis of extreme events"24 July2019. https://doi.org/10.1002/joc.6247.

[7] Salman, A. S. 2017.Unidirectiontrends in daily rainfall extremes of Iraq, *Theoretical and Applied Climatology*, pp1-13. doi:10.1007/s00704-017-2336-x.

[8] Rousta, I.; Nasserzadeh, M.H.; Jalali, M.; Haghighi, E.; Ólafsson, H.; Ashrafi, S.; Doostkamian, M.; Ghasemi, A. Decadal Spatial-Temporal Variations in the Spatial Pattern of Anomalies of Extreme Precipitation Thresholds (Case Study: Northwest Iran). *Atmosphere* 2017, *8*, 135. doi: 10.3390/atmos8080135.

[9] Deng, L., M. F. McCabe, G. Stenchikov, J. P. Evans, and P. A. Kucera, (2015). Simulation of Flash-Flood-Producing Storm Events in Saudi Arabia Using the Weather Research and Forecasting Model. *J. Hydrometeo.*, 16, 615–630, https://doi:org /10.1175 /JHM-D-14-0126.1.

[10] De Vries, A. J., Tyrlis, E., Edry, D., Krichak, S. O., Steil, B., & Lelieveld, J. (2013). Extreme precipitation events in the Middle East: Dynamics of the Active Red Sea Trough. Journal of Geophysical Research: Atmospheres, 118(13), 7087–7108. doi:10.1002/jgrd.50569.