

## Statistical Analysis of Fluctuations in Kermanshah's Maximum Temperature and its Time Series Forecast

<sup>1</sup>Dariussh Yarahmadi, <sup>1</sup>Parsa Gholami, <sup>2</sup>Saeid Olfati and <sup>3</sup>Khadijeh Moradi

<sup>1</sup>Department of Geography Science, Lorstan University, Iran

<sup>2</sup>Department of Climatology, Yazd University, Iran

<sup>3</sup>Department of Geomorphology, Esfahan University, Iran

**Abstract:** Fluctuations maximum temperature of Kermanshah province of Iran and world nowadays one of the most important discussions in the scientific circle is the discussion about climatic changes' increase in the average temperature of the globe and its consequence that more or less has been paid attention to in our country as well. In this research the attempt was to pay attention to the survey of increase data in the maximum temperature of Kermanshah. Thus the annual absolute maximums of date in the specific station during a 50-year period (1961-2010) have been used. The correlation method (logarithmic' poly nominal) and Mann- Kendall statistical test have been used for testing the meaningfulness of fluctuation direction of series temperature and its diagram has been drawn by using the MATLAB software. The results show that the temperatures of two decades of 1970 and 1980 have been lower and three decades of 1990 and 2000 have been higher than the long-term average and the decade of 1980 has been the coldest of the decades. The general result of this research shows that there are seasonal fluctuations in maximum temperature of Kermanshah which are not meaningful. The model of halt winter has been recognized as the best model for predicating the temperature of maximum extreme of Kermanshah which the diagram in a Minitab was drawn and the results of this predication shows that there is an abnormal increase in the temperature of 2014 and 2019.

**Keywords:** Decade's direction, halt-winters, kermanshah, mann-kendal, maximum temperature

### INTRODUCTION

The temperature of the elements which are directly related to climatic conditions and welfare of human life and its role in human activities and natural processes is undeniable. The precipitation temperature is considered the most important elements in determining the role of climate and climate affect the distribution of other elements (Alijani and Joseph, 1384). The sharp changes in temperature adversely impacts to biological life forms. Among the adverse effects of temperature changes is (hot and cold wave) loss of organisms in the ecological conditions of low and high temperature range. Similarly the effects of this phenomenon on the climate construction of facilities and buildings is very high and the occurrence of such phenomena losses will be very large. Increase in energy consumption during the occurrence of this phenomenon is including their adverse effects. Nowadays, climate change science and its application to a large extent, is considerable importance And understand the causes and nature of these changes, the most important objectives is data collection weather and climate monitoring and climate phenomena (Khorshiddost *et al.*, 1388, 1389). Increase in average global temperature profile and changes of climate change is the whole idea to consider climate change Ma And an increase in the frequency of occurrence in the dry watched. Mohammadi and

Taghavi (1384) analyzed climate change with seasonal and annual rainfall examined and an increase in the frequency of occurrence in the dry was watched (Jafari, 1987). Troposphere temperature monitoring using time series shortwave atmospheric observations of climate change with high spatial and temporal coverage tested.) and the changes in mean seasonal and annual rainfall, the water in Greece using data from high atmospheric probes studied (Krysvlakys and colleague 2003) studied the effects of climate change on hydrology and water resources in Switzerland. Spark and Janvsky (2005) studied potential impact of climate change and how to identify and features one of the region (Azizi and Asghar, 1984) also believe that the best method of mathematical regression model of is the rainfall distribution changes. Cade and Noon (2003) examined temperature and precipitation trends in South Korea showed that the mean annual temperature had a decreasing trend and precipitation had an increasing trend (Modaresi *et al.*, 1989) to adapt to climate change began with drought. Ghorbani and Afshin (1381) Fluctuations of temperature and precipitation Gorgan analyzed using simple linear regression and concluded that no increased temperature and precipitation are decreasing. Ebrahimi and Soheila (1984) in Mashhad plain of climate change on monthly changes in temperature using Kendal and Ltn Maier showed that the temperature has risen in most months. Rahim Zadeh

et al. (1384), the scale and the scale of annual of daily existence, such as process variations, mutations, unusual fluctuations, changes in the distribution function Average annual and other elements were found. Zahedi et al. (1386) and Alijani and Joseph (1384) Temporal-spatial temperature North West and Iran Tabriz station average temperature anomalies were performed using statistical methods. Rzyyy et al. (1384) the annual rainfall in arid and semiarid regions of Central and East Iran, were investigated using non-parametric tests And concluded that the precipitation in these areas has been declining. Parsley (1387) has stated that the Caspian region, the climate of the past half century has been warmer climate forests of Caspian. Among other relevant studies can (Ghaior and Montazeri, 1988; Masoudian, 1383; Asakereh, 1386a, b, 1389; Feizi et al., 1389; Khoshhal and Joseph, 1987) pointed out. According to the research work done on it Extreme temperature fluctuations and high forecast of the Kermanshah engage in statistical methods.

### MATERIALS AND METHODS

To conduct this study, the maximum temperature corresponding to the maximum absolute annual (so that all the data in each of the daily maximum temperature and extracted each year specified) During a 50-year period from 1961 to 2010 were used Kermanshah Province Kermanshah synoptic station as flagship station is coordinates 34° 21 min north latitude and 47° 9 min east longitude minutes.

After quality control, in order to conscious integrity of the data, the statistical analysis of the data Done; This process includes tracing the long-term trend analysis and the nonparametric test man Kendall And then using time series Holt-Winters for forecasting extreme temperatures over 2020 Stations of Kermanshah. In order to analyze the temperature fluctuations during extreme maximum 50-year period by period was divided into 5 The first period from 1961 to 1969, second period from 1970 to 1979, The third period, from 1980 to 1989, during the fourth round of the 1990 to 1999 and fifth 2000 to 2010 are included. The volatility and the overall series and 1990-series and 2010 were analyzed. To calculate the maximum temperature anomalies Kermanshah station from Eq. (1) is used:

$$A_{ET} = CT \max - \bar{CT} \max \quad (1)$$

$A_{TE}$  Extreme maximum temperature anomalies in the above equation, Extreme maximum temperature anomalies,  $CT \max$  the maximum temperature recorded each year in the 50-year period  $\bar{CT} \max$  average maximum temperature be 50-year long-term station. Non-parametric test Mann-Kendall test for trend detection means you jumps in the time series is used. In this method, two factors  $U_i$  and  $U'_i$  together are calculated and plotted for review and their position relative to the mean or indicates the significance of the

process. If two threshold values of  $\pm 1/96$  exceeds the mean would be cut if two lines meet in a point to point, point mutations. If the two lines are in space, meaning mutation was not found, but an invasion of privacy or have left the area altogether or temporarily mutations would be meaningless. Also, if two sequences are depicted graphically according to  $i$ , the mean ing process, the two curves will intersect at the starting point, In the absence of the two sequences and will move almost parallel Or several times to change their behavior so that it does not result, they act . Confluence  $U'_i$  in the range of 95% Represents a significant change between the time series of climate and at the confluence of the descending or ascending a series of climate specify. Two line  $U_i$  and  $U'_i$  graphs in that they do not collide or not confluence of the two lines represents the series are not climate (Khoshhal and Joseph, 1387) in the test, due to lack of normal distribution of extreme maximum temperatures are likely Kermanshah, A polynomial method or poly Nvmyal grades 2, 3, 4 and 6 are used to map and analyze the temporal fluctuations. A polynomial equations are called quadratic equations of the second, third and fourth grade sixth grade are also called Time series data on which they are capable not a straight line, they are an appropriate model for analysis of long term trends. The trends in the graph above, depending on the degree of positive or negative contribution to the concave or convex or  $\beta$  combination. Sixth grade can continue to be part of the equation or polynomial regression in which case it is called poly Nvmyal. The regression equation developed from the poly Nvmyal widely used. The overall shape or Plynvmyal polynomial model is:

$$Y_t = \alpha + \beta_1 X + \beta_2 X^2 + \beta_3 X^3 + \beta_4 X^4 + \beta_5 X^5 \quad (2)$$

If it is determined that the probability distribution is nonlinear time series charting the spread or dispersion with long, linear shape guessed it. The addition of time-series averages of the components of cycle or a cycle of components, the components are seasonal and irregular fluctuations. Time series of maximum temperatures expected to beat Kermanshah pre form equation is shown below:

$$Y_t = M \times T \times C \times S \times I \pm e \quad (3)$$

In the above equation  $Y_t$  time series pre projected, M-series average, T component, process, C a cycle component, S seasonal component, I irregular oscillations are observed during a series of e errors The model predicts Holt-Winters on the basis of weighted average of the current and previous values of the time series data recorded. Weigh out about the latest greatest weight to the view that the time series data and time-series data back, to be less weights. In this model, it is necessary to pre projected components  $\bar{X}_t$ ,  $T_t$  the component level or out of order and seasonal trends are estimated. And respectively the component level or average and seasonal trends are estimated. Collective

mode prediction model Holt-Winters used in this study is as follows:

$$\bar{X}_t = (\bar{X}_{t-1} + T_{t-1}) + (1 - \alpha) \left( \frac{X_t}{F_{t-s}} \right) \quad (4)$$

$$T_t = \beta T_{t-1} + (1 - \beta)(\bar{X}_t - X_{t-1}) \quad (5)$$

$$F_t = \gamma F_{t-s} + (1 - \gamma) \left( \frac{X_t}{\bar{X}_t} \right) \quad (6)$$

In the above equations: the latest view:  $\bar{X}_t$  and the coefficients of the model  $\alpha$ ,  $\beta$ ,  $\gamma$  are exponential smoothing Holt-Winters. The numerical value between zero and one variable. If the time series covering the period  $F_{t-s}$  or periods in particular, Seasonal component corresponding period of the previous year, will be shown. Reaching values of  $n$  time series based on  $(y_{n-h})$  the following equation can be pre projected:

$$F_{t-s} + \hat{y}_{n-h} = y_{n+h} T_n \quad (7)$$

### RESULTS AND DISCUSSION

The statistical properties of extreme maximum temperatures Kermanshah station after the data is contained in Table 1. Considering the long-term mean temperatures, extreme maximum and average five decades in comparison with the period determined. The average temperature below 2 decade 1970 and 1980 than the average 50-year at the 1960, 1990 and 2000 have higher than average long-term under. In the decades between the 1980s and the first decade of the 21<sup>st</sup> century are coldest or warmest decade Kermanshah station (Table 1).

As Table 1 comes back index of the dispersion, extreme maximum temperature of the first decade of the 21<sup>st</sup> century have more order and stability extreme maximum temperature in the 1960s is less than the order. Comparing the two periods 2010-1961 and 2010-1990, as well as statistical term that represents Increased to 42/0°C. The maximum temperature in the past 21 years. As the temperature falls to a very small number of place +/42 a number of very significant that it can be considered a serious warning. Extreme temperatures, high levels of skewness for all series indicated that Asymmetry (deviation from a symmetric

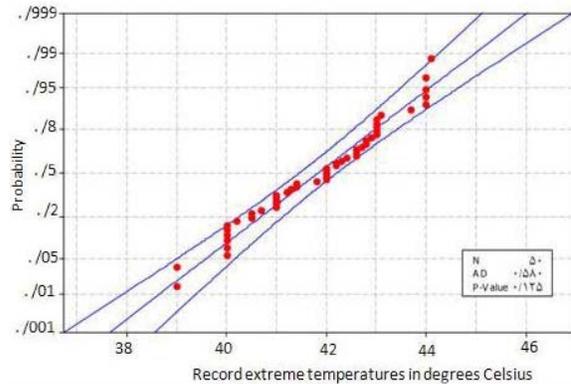


Fig. 1: Distribution of log normal statistical probability of extreme maximum temperature Kermanshah station

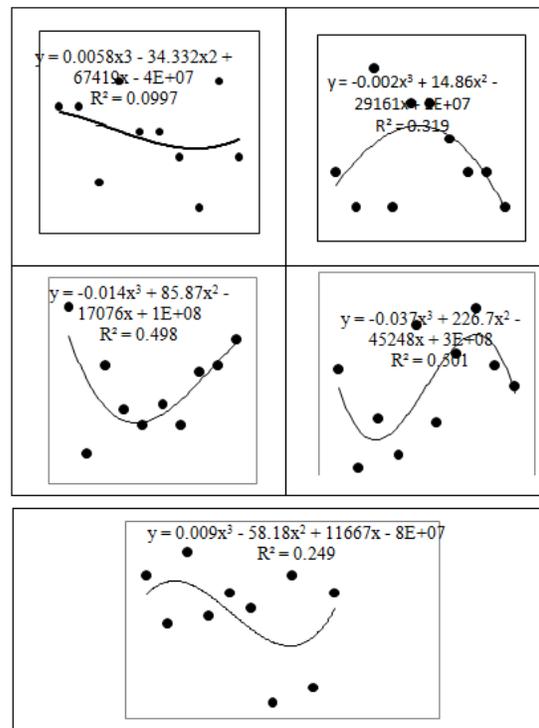


Fig. 2: The maximum extreme temperature fluctuations decade Kermanshah station (1961-2010)

distribution) and skew to the left, all series except the 1980 series. Except the decade 1970s and 2000s, which is very different from a normal distribution, the

Table 1: Maximum extreme temperature indices described by at different periods of time

Statistical indicators	Period statistical						
	1961-2010	2010-1990	1970-1961	1980-1971	1990-1981	2000-1991	2001-2010
Average	41/84	42/24	42	41/5	41/3	42/2	42/3
Standard deviation	1/36	0/99	1/66	1/43	1/51	1/3	0/61
Coefficient of Variation	3/25	4/62	3/95	3/45	3/66	3/08	1/44
Minimum	39	40/2	39	40	39	40/2	41/2
Maximum	44/1	44/1	44	44	44	44/1	43/1
Domain	5/1	3/9	5	4	5	3/9	1/9
Skewness	-0/20	-0/39	-0/35	0/57	0/31	-0/12	-1/01
Elongation	-0/77	-0/01	-0/72	-1/00	-0/45	-1/01	0/25

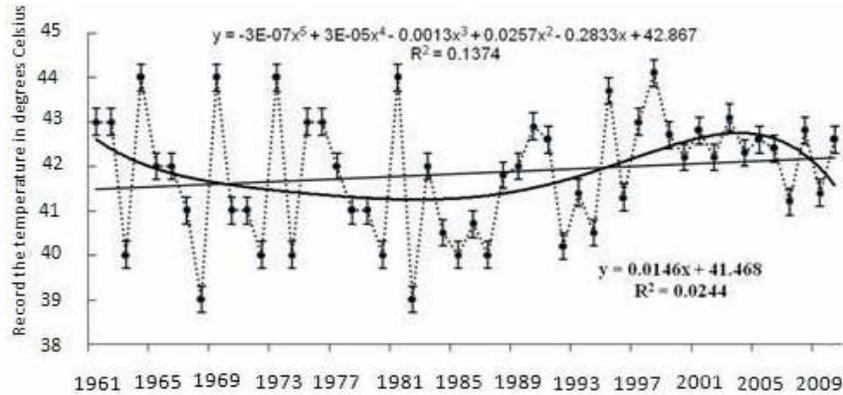


Fig. 3: Long-term trend of a linear and a quadratic extreme maximum temperatures of five stations of Kermanshah

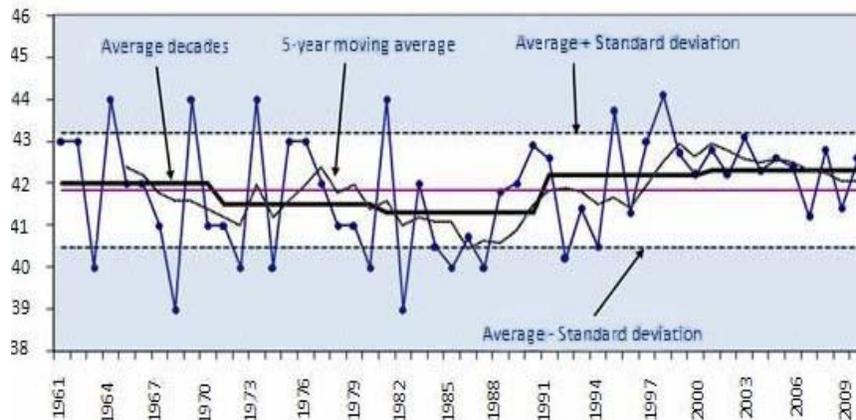


Fig. 4: Maximum extreme temperature anomalies Kermanshah stations (1961-2010) and five-year moving averages and a decade

skewness between the absolute figures are 0/1 and 0/5 With a normal distribution of the statistical distribution of their distance, like 50-year series of log normal distribution (Fig. 1) is.

Elongation values of extreme maximum temperatures below zero series, based on the five series are shorter than normal. In order to better detect a condition when temperature fluctuations decades, the extreme maximum temperature during the five decades of Kermanshah station Note that in Fig. 2 below to be.

As seen in Fig. 2 decades 5 of changes in any of the extreme maximum temperature is not linear Kermanshah station Regression function that contributes to the intensity variations among the studied decades of the 1980s and 1990s when the trend is much stronger than the other. Long-term changes in extreme temperature peak linear and quadratic regressions Kermanshah using six of the last 50 years is depicted in Fig. 3. Given the general trend of the maximum temperature Kermanshah changes gradually upward climb. Given the general trend of the maximum temperature Kermanshah changes gradually upward climb. However, the extreme maximum temperature

Kermanshah gradual changes when using the six degrees Plynvmyal shown in mid-2000 Series (2005) shows a sharp decline almost.

Given the long-term average of 84/41 and a standard deviation of long-term 36/1 for the extreme maximum temperature of Kermanshah, Control line low (mean-SD) temperature 84/40°C And the upper control line (mean+SD) with temperature 14/43°C As the extreme maximum temperature threshold of positive and negative abnormal Kermanshah are introduced. So the normal maximum temperature extreme temperatures Kermanshah were between 84/40 to 14/43°C (Fig. 4). Positive temperature anomalies of extreme temperature figures Kermanshah maximum daily temperature is above 14/43°C Negative temperature anomalies temperature and maximum temperature values are less than 14/43°C The dark color in Fig. 4 are marked.

Extreme maximum temperature anomalies in Fig. 4 Kermanshah with a 5-year moving average (fixed lines) is quite normal. Extreme positive and negative temperature anomalies in Kermanshah maximum 6 points and 9 points above the bottom are quite clearly. threshold limit of the normal and extreme high and low

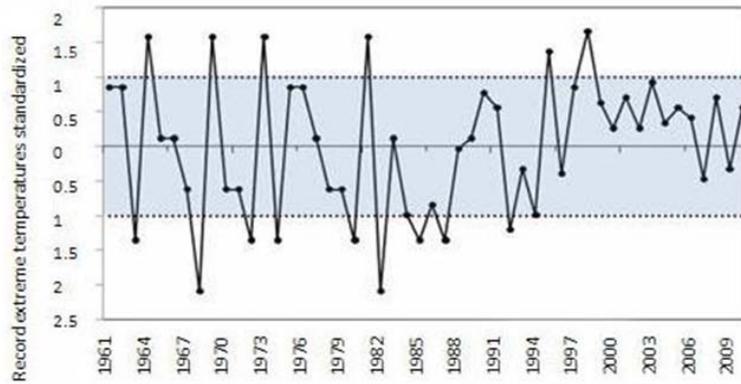


Fig. 5: Standardized anomalies of extreme temperature maximum Kermanshah station (1961-2010)

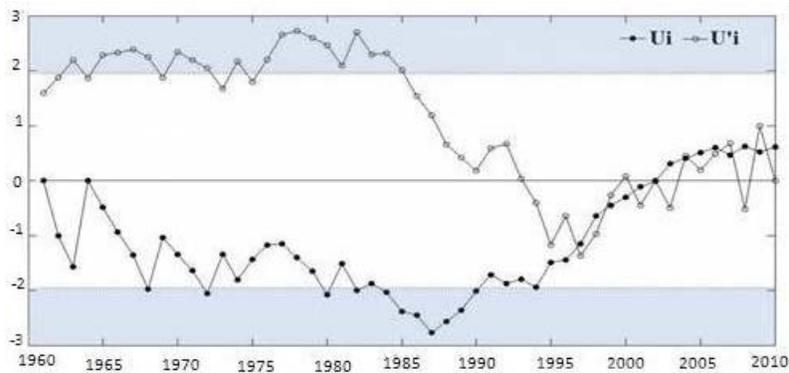


Fig. 6: Graph man-Kendal to detect temporal changes in extreme maximum temperatures Kermanshah station (1961-2010)

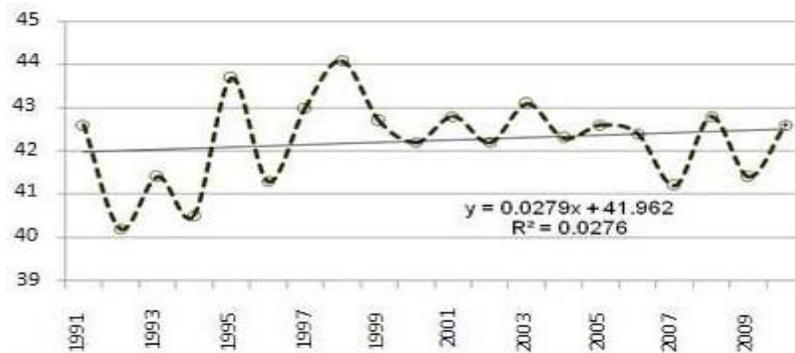


Fig. 7: Maximum extreme temperature changes (1991-2010) stations Kermanshah

temperatures, extreme maximum Kermanshah which are standardized in (Scores between  $\pm 1$ ) (Fig. 5) indicated that extreme maximum temperatures Kermanshah most years in the normal range (dark area in Fig. 5) is located Only in 1964, 1969, 1973, 1981, 1994 and 1997 is strongly in the range of positive anomalies.

Using a non-parametric test Man-Kendall found that the maximum extreme temperature changes when Kermanshah despite showing no significant trend of increasing (Fig. 6). As seen in Figure But the extreme

temperature changes in the mean Kermanshah is no maximum. 5 extreme temperature changes while maximizing long-term changes in the average will show.

The results of Man-Kendal method was to show the 21-year trend from 1990 to 2010 despite a linear increase in Kermanshah station and about 3%, no significant changes during the 21 years (Fig. 7).

Due to the extreme maximum temperature in Kermanshah 50-year period from 1961 to 2010 and also increased over the past 21 years, Using time series

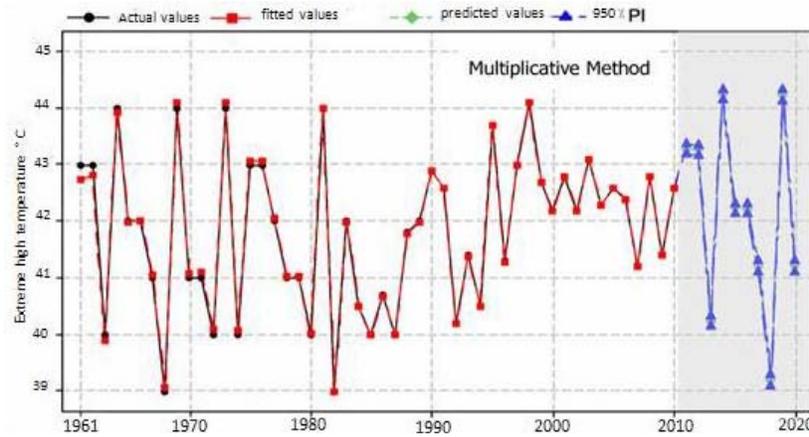


Fig. 8: Pre extreme maximum temperatures predicted in 2020 using holt-winters

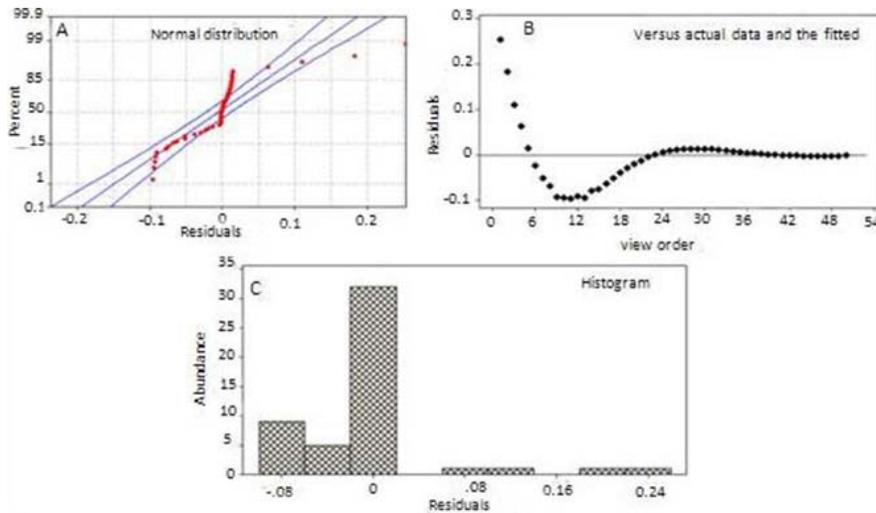


Fig. 9: (A) distribution of normalized residuals, (B) diagram linear distribution between actual and predicted values, (C) histogram of the frequency of the after holt-winters model

Holt-Winters extreme maximum temperature Kermanshah next 10 years was estimated that pre in 2020 about Given that the model in Fig. 8, the years 2011, 2012, 2014 and 2019 is higher than the upper threshold, the Years 2013, 2015, 2016, 2018, 2017 and 2020 and only the normal threshold was lower than normal threshold. Based on this forecast, between 2014 and 2019 with temperatures 3/44°C and the warmest years in the real temps projected to be Kermanshah.

As points of comparison and the fit of the model as well as pre projected curves shown in Fig. 9, In more extreme cases, maximum temperatures range Kermanshah, had adapted quite well Species of the not possible to determine the actual values of the fitted values. This indicates the accuracy of the model nose.

This study measures the accuracy of the model for the mean absolute deviation equal to 0/035 Mean square deviation equal to 0/00377 and mean absolute percent error equal to 0/084 are estimated this is to

show the validity and accuracy of the model as idea is organic.

## CONCLUSION

The results show that the distribution of the probability of recurrence given extreme maximum temperature was not normal in the Kermanshah Instead of the normal logs will follow. In fact, the show is log normal Linear methods have limitations due to non linear part (Plynmmyal) can be used Due to the extreme temperatures of maximum long-term average and the results were compared with the temperature during the 5 1960, 1990 and 2000, higher And the 1970 and 1980 to be below average are 50 years. In this regard, the coldest 1980s and 2000s warmest decade of Kermanshah. Comparison of long-term period of 2010-1961 and 2010-1990 show the increase in 0/42°C maximum temperature during the last 21 years. None of

the studied extreme temperature changes in the peak intensity changes of Kermanshah not linear and parabolic regression will follow decade long trend in the 1980s and 1990s when the trend is much stronger than the other. The general trend of the maximum temperature change is gradual upward climb. However, the extreme maximum temperature Kermanshah gradual changes when using the six degrees Plynmvmyal shown in mid-2000 Series (2005) show a sharp decline. Extreme maximum temperatures in the normal range located in Kermanshah more years. Only in 1964, 1969, 1973, 1981, 1994 and 1997 is strongly positive anomalies in the range. Using the Mann-Kendall found. The maximum extreme temperature changes when Kermanshah despite showing no significant trend of increasing the maximum extreme temperature changes, although the changes in long-term averages will show. But the extreme maximum temperature changes in the Kermanshah is no mean. Meanwhile, the 21-year Kermanshah station from 1990 to 2010 despite a linear increase of about 3%, no significant changes during the 21 years. The results of the model Holt - Winters it was obtained during 2011, 2012, 2014 and 2019 is higher than the upper threshold, Years 2013, 2015, 2016, 2017 and 2020 the normal threshold and only 2018 was lower than normal threshold. The years 2014 and 2019, with temperatures 3/44°C warmest years. Between the actual temperature and the pre projected to be Kermanshah. Measures the accuracy of the model prediction Holt-Winters and the normal distribution and histogram frequency data showed and The validity of the method was applied to predict the acceptable level. And quantities been projected with the distance. High reliability. Printable the occurrence.

## REFERENCES

- Alijani, B. and G.R. Joseph, 1384. Compared to projected changes in annual temperature and pre Tabriz with the global temperature anomalies using linear regression. *ANN Geography and Development Issues*, No. 6.
- Asakereh, H., 1386a. Shift-when precipitation in Iran during the statistical year 2003 to 1963. *J. Geogr. Dev.*, 10: 145-164.
- Asakereh, H., 1386b. *Climate Change*. 2nd Edn., Zanjan University Press, Zanjan, Iran.
- Asakereh, H., 1389. An average annual temperature cycle analysis of Zanjan. *Geogr. Dev.*, 19: 11-24.
- Azizi, G. and R.A. Asghar, 1384. Of droughts-and the possibility of pre wet nose using time series models Holt - Winters in the province. *Geogr. Res. Quart.*, 79: 48-63.
- Cade, B.S. and B.R. Noon, 2003. A gentle introduction to quantile regression for ecologists. *Fronties Ecol. Environ.*, 1: 412-420.
- Ebrahimi, H.A. and A.J. Soheila, 1384. Check the temperature profile of climate change in the region of Mashhad. *Geogr. Res.*, 79: 5-18.
- Feizi, V., M. Faraj-Zadeh and R. Naorozi, 1389. Study of climate change in the Sistan and Baluchestan my way-Kendall. *Proceeding of 4th International Congress of the Islamic World Geographers*.
- Ghaior, H.A. and M. Montazeri, 1388. A comparative analysis of the rainfall and drought Caspian basin. *Geogr. Dev.*, 16: 71-92.
- Ghorbani, M.H. and S. Afshin, 1381. Evaluation of climate change Iran over the last 40 years. *J. Agric. Natl. Resour.*, 36: 3-14.
- Jafari, M., 1387. Research and analysis over the past 50 years of climate change on forests Caspian region. Iran. *J. Forest Poplar Res.*, 32: 314-326.
- Khoshhal, D. and G.R. Joseph, 1387. I used nonparametric tests MAN-Kendall's estimate temperature changes (Case Study: Isfahan). *J. Geogr. Space*, 22: 21-38.
- Khorshiddost, M.A., G. Rahimi and S.R. Yusuf, 1388. Predication forecast using time series of extreme temperatures. *J. Geogr. Space*, 9(26): 31-48.
- Khorshiddost, M.A., G.R. Joseph and A.M. Karim, 1389. The application of large-scale patterns of atmospheric-oceanic rainfall fluctuation analysis (Case Study: Ahar station). *J. Geogr. Space*, 29: 95-128.
- Masoudian, A., 1383. Evaluation of temperature trends in the past half century. *Geogr. Dev.*, 3: 89-106.
- Modaresi, F., I. Race, K. Shahab Ebrahimi and M. Majid, 1389. A study of the phenomenon of climate change using statistical test (Gorgan River Basin Case Study-Su Karabakh). *J. Soil Water*, 3: 476-489.
- Mohammadi, H. and F. Taghavi, 1384. In Tehran process parameters such as temperature and precipitation. *Geogr. Res.*, 53: 172-151.
- Rahim Zadeh, F., E. Fattahi and S.F. Hosseini, 1384. Change in climate variability in interest from statistical models. *J. Iran. Res. Resour.*, 2: 61-73.
- Rzyyy, T., P. Danshkararasteh and B. Saghafi, 1384. Of the annual rainfall in arid and semiarid regions of Central and East Iranian. *J. Water Wastewater*, 16: 73-81.
- Zahedi, M., S.B. Sari and J. Jamaei, 1386. Analysis of temporal changes-a place at the North West of Iran. *J. Geogr. Dev.*, 10: 183-198.