Seasonal temperature fluctuation and change during 1961-2008 in Turkey

Hüseyin Toros[1], Ali Deniz[2], Mustafa Coşkun[3] and Ali Özturk[4]

Abstract: Turkey is a Mediterranean country and it is a transcontinental European and Asian country. Its geographical location is important for different climatic transition regions. In this study, daily maximum and minimum air temperature data from 165 stations were used to study the temperature fluctuation in the period of 1961-2008 in Turkey. Homogeneity for data quality and non-parametric Mann-Kendall correlation statistical tests for statistically significant increasing or decreasing trends have been assessed in the 48-year period. The results show that there is increasing trend in all seasonal maximum temperature but only the summer and autumn is significant. There is also a significant increasing trend in the summer minimum temperature.

Key words: Climate change, Mann–Kendall test, Temperature, Turkey

1 INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) [1] and a lot of other studies stated that there is a climate harmful effect on the human and environmental future due to changes in climate. Some of the anticipated effects of climate change are on hydrological systems, agriculture, food security, tourism and energy demand, both at local and global levels. There are excessive studies on climatic change from the past to the future. It is a difficult subject due to change in climate, which is a result of many factors like human effect, nature and sun activities. The IPCC projects that, without further action to reduce greenhouse gas emissions, the global average surface temperature is likely to rise by a further 1.8-4.0°C this century. There have been many studies undertaken in order to understand the climate change in Turkey [2-6]. Toros [7] showed that there is an increase in temperature and a decrease in precipitation in some selected cities in Turkey. Karaca [8] denotes that the climatic oscillations of Turkey will give a hint about world climate change, because the location of Turkey plays a larger role due to its middle latitudes since it is a transition zone between Europe and Asia. The goal of this study is to present a detailed analysis of seasonal temperature fluctuation and change during 1961-2008 in Turkey.

1 Author is with the Department of Meteorology, Faculty of Aeronautics and Astronautics, Istanbul Technical University, Maslak, Istanbul 34469, toros@itu.edu.tr
2 Author is with the Department of Meteorology, Faculty of Aeronautics and Astronautics, Istanbul Technical University, Maslak, Istanbul 34469, denizali@itu.edu.tr
3 Author is with the Turkish State Meteorological Service, Kalaba, Ankara 06120, mcoskun@dmi.gov.tr
4 Author is with the Department of Chemical Engineering, Faculty of Chemical and Metallurgical Engineering, Istanbul Technical University, Maslak, Istanbul 34469, kmali@itu.edu.tr

2 STUDY AREA, DATA AND METHODOLOGY

Turkey is the world's 37th largest country and lies at the southeastern of Europe and Asia., encircled by the Mediterranean Sea to the south, the Black Sea to the north and the Aegean Sea to the west. Turkey's topography consists of a high central plateau with narrow coastal plains, between the Köroğlu and East-Black Sea mountain range to the north, the Taurus Mountains to the south and Turkey's highest point with more than 5000 m height. The coastal areas of Turkey have a hot temperature, usually on the southern and southeastern side, dry in summers and mild, wet and cold winters. Turkey's annual precipitation averages are about 650 mm, 2200 mm in northeast side and this decrease to 300 mm center of Turkey. Annual minimum temperature averages is about 1.5 °C, and maximum temperature averaged is about 25 °C.

The maximum and minimum temperature data used here were provided from the Turkish State Meteorological Service (TSMS). All station seasonal data averages values is analysis for seasonal fluctuations. Homogeneity for data quality is tested by using a procedure involving the Wald–Wolfowitz runs test [7]. The non-parametric Mann-Kendall (MK) rank correlation statistical test for significant increasing or decreasing of trends has been applied. Mann-Kendall tests results u(t) represent increasing and decreasing in time series. When u(t) value is higher than 1.96 that shows a 95% significant increase or u(t) value is lower than -1.96 that show there is a 95% significantly decreasing trend in the time series data. When Mann-Kendall statistic of a time series u(t) is near 1.96 or -1.96, there is an increasing or decreasing trend but it is not significant or u(t) and u'(t) approach zero that show there is no trend in the time series [7,9]. In this study, the average value of all stations' time series

(upper panel) plots (solid) is depicted with the linear trend (dashed), Mann-Kendall statistical test (below panel) u(t) (dashed) and u'(t) (solid).

3 RESULTS AND DISCUSSION

Seasonal maximum and minimum temperature time series analyses have been investigated with all 165 stations average data using least square and the Mann-Kendal rank correlation statistical test. The Mann-Kendall test 95% confidence level bands are shown with a dashed line (±2) in the below panel in all figures.

Winter season averages values of all station time series, linear trend and MK rank correlation test values is given in Figure 1. Least square values show an increasing trend in all periods of data. There is a decreasing trend until 1977 and then an increasing trend after that time regarding maximum temperature in winter. As seen in Figure, 1 there is an increase, usually after 1993. The first period of the 1962-1977 MK rank correlation test reached a significant level.

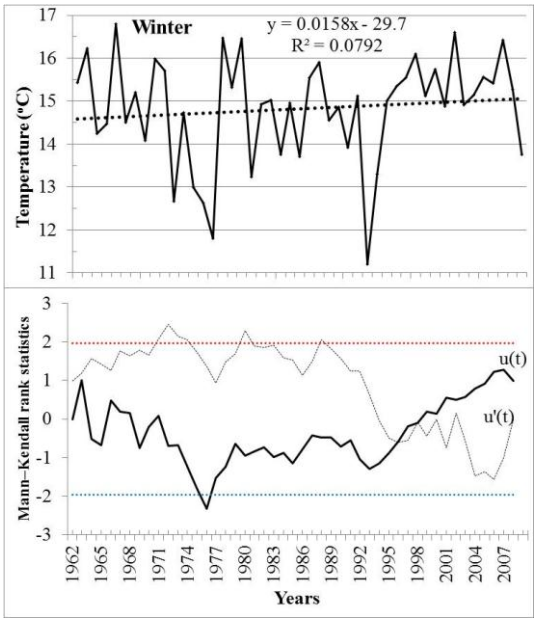

Fig. 1. Maximum temperature time series, linear trend and MK rank correlation statistics in winter.

Spring season maximum temperature average value time series, least square linear trend and MK rank correlation test values are given in Figure 2. As seen Figure 2 least square values show that there is an increasing trend in the spring. MK results show that there is no trend before 1988 but there is an increasing trend after 1988 and this increasing trend is not at a significant level.

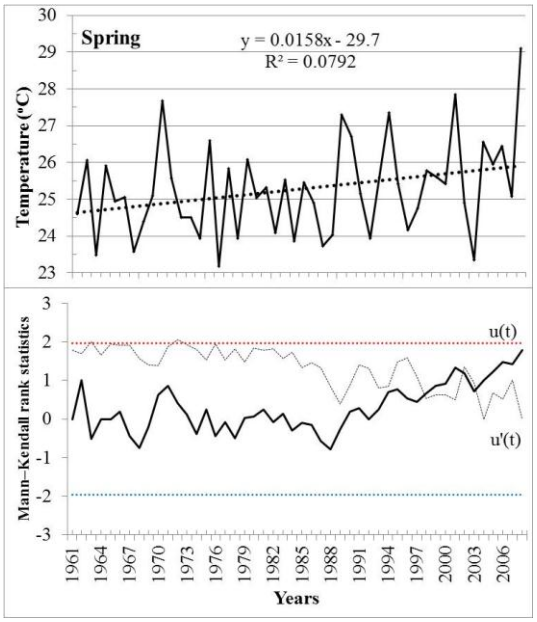

Fig. 2. Maximum temperature time series, linear trend and MK rank correlation statistics in spring.

Summer season maximum temperature average value time series, least square linear trend and MK rank correlation test values are given in Figure 3. Summer season maximum temperature is an increasing trend with least square method. This increasing trend begins in 1988 and this increasing trend is not at a significant level.

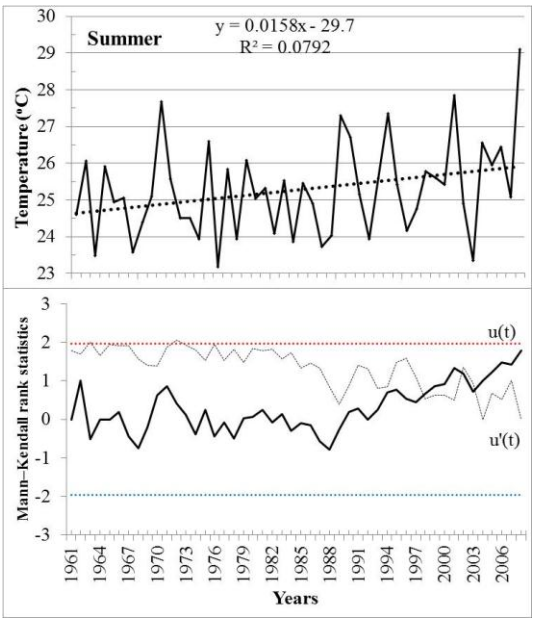

Fig. 3. Maximum temperature time series, linear trend and MK rank correlation statistics in summer.

Autumn maximum temperature average values time series, least square linear trend and MK rank correlation test values are given in Figure 4. As seen in Figure 4, there is an increasing trend both least

square and MK rank correlation test and MK test has a significant level. Maximum temperature has a two decreasing and two increasing period. This fluctuation decreased in 1962-1971, 1973-1981 and 1983-1987 and increased during 1988 to 2008.

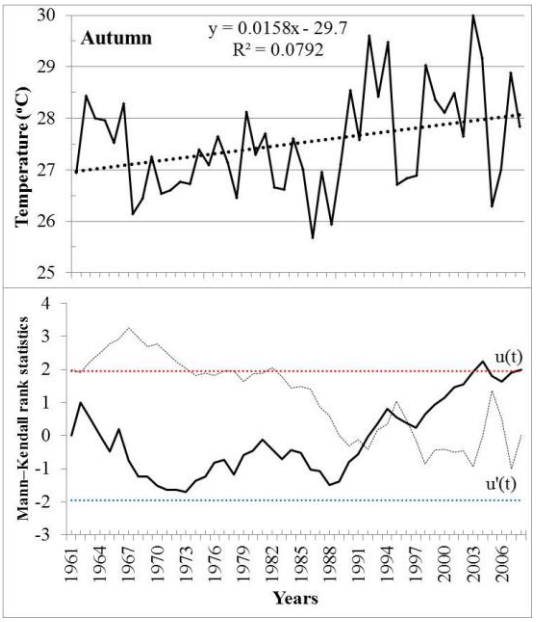

Fig. 4. Maximum temperature time series, linear trend and MK rank correlation statistics in autumn.

Minimum temperature time series (upper panel), least square linear trend (upper panel) and MK rank correlation test values (bottom panel) of winter season are given Figure 5. There is no linear trend or MK test in significance level from 1961 to 2008, but as seen in the MK test there is a decrease between 1962-1976, an increase in 1977-1984, a decrease in 1985-1993 and an increase after that time.

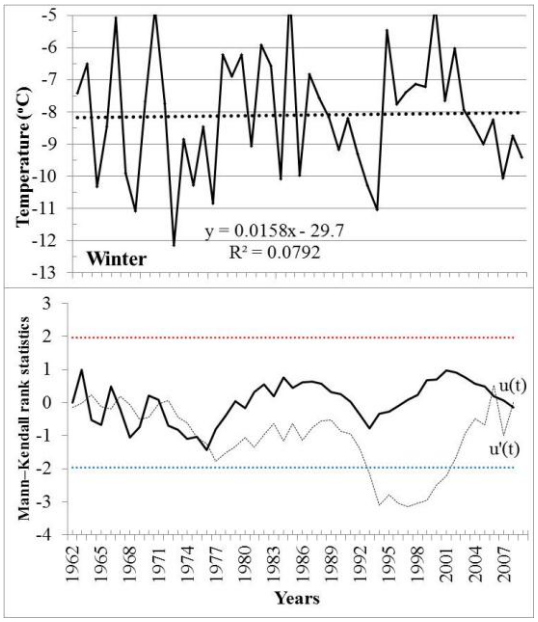

Fig. 5. Minimum temperature time series, linear trend and MK rank correlation statistics in winter.

Time series of spring season minimum temperature is given in Figure 6. There is an increase in minimum temperature in both linear trend and MK rank correlation test with a significant level. There is an increase until 1980 than there is a decrease until 1989 and after this time the increasing trend began.

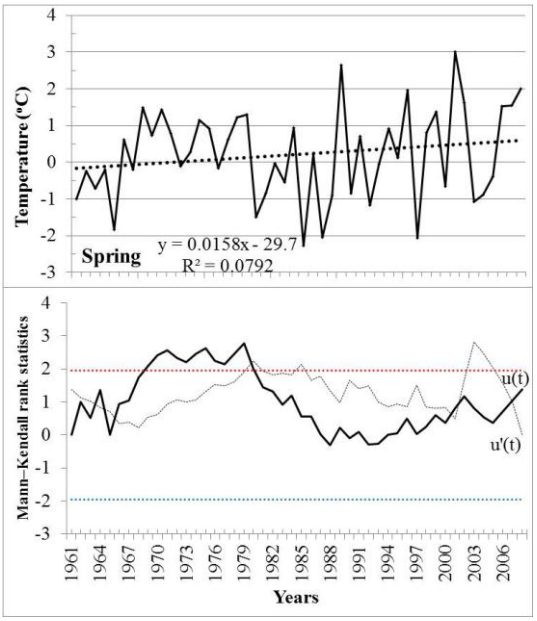

Fig. 6. Minimum temperature time series, linear trend and MK rank correlation statistics in spring.

Time series of summer season minimum temperature is given in Figure 7. There is an increase in minimum temperature in both linear trend and MK rank correlation test with significance level. The increase trend began in 1969 and continued up to the present date.

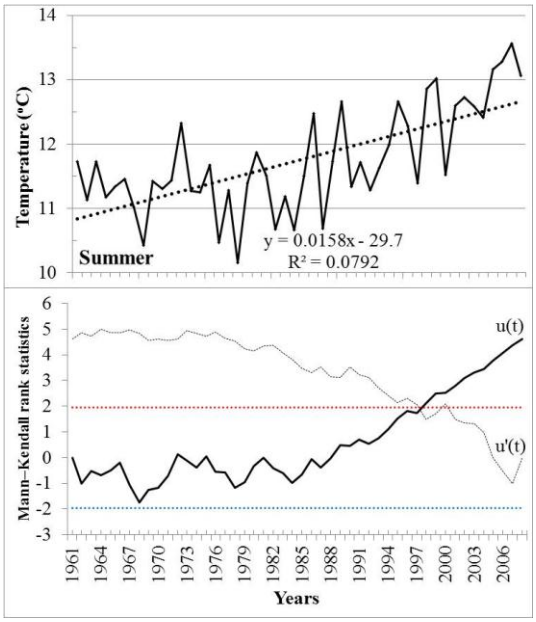

Fig. 7. Minimum temperature time series, linear trend and MK rank correlation statistics in summer.

Time series of autumn season minimum temperature is given in Figure 8. There is an increase in minimum temperature in both linear trend and MK rank correlation test but not of a significant level.

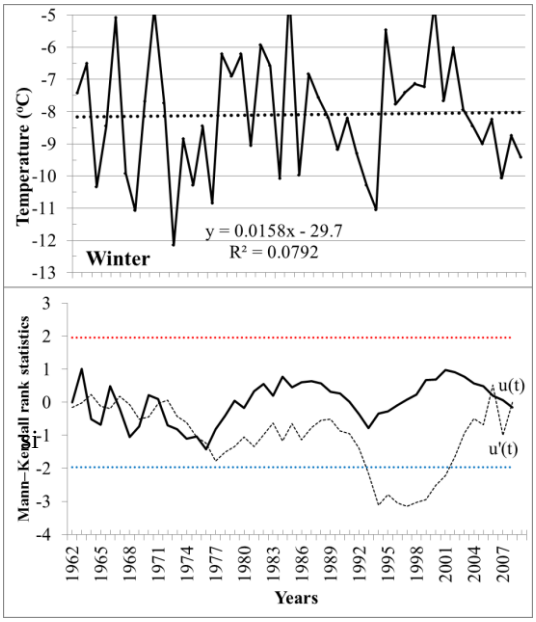

Fig. 8. Minimum temperature time series, linear trend and MK rank correlation statistics in autumn.

4 CONCLUSIONS

In this study, seasonal maximum minimum air temperature data series from 165 stations across Turkey were examined for the climate change in the period of 1961-2008. Generally, the average of all stations shows significant increasing trends in all season in both maximum and minimum temperature. MK rank correlation shows that only autumn in maximum, and spring and summer in minimum temperature had a significant level.

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