Identification of Synoptic Patterns Influencing Formation of Temperature Anomalies in Iran and Europe

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Received: 13/11/2013 Accepted: 14/10/2014

Introduction

Climate is a system consisting of atmosphere, lithosphere, cryosphere, hydrosphere, and biosphere. This system is involved in the exchange of energy and moisture among these five components. The exchanges link the atmosphere as the central component of the climate to other spheres. Changes do not occur separately in this system; rather change in one component contributes to reaction of other components. In synoptic scale, changes in each of these components cause changes in atmosphere patterns and changes in the climate of regions are affected by these patterns. In terms of climate, Iran is located in transition zone and influenced by different weather patterns in different seasons of the year. One of the effective ways to understand the changes and occurrence of temperature extremes is to identify the effective mechanisms in their formation. This study examines the effective synoptic patterns during the different temperature conditions between Iran and Europe to detect their relations in the past.

Materials and Methods

In order to fulfill the present study, statistical-synoptic methods were used. To determine cold and hot cycles, data of maximum, minimum, and average daily temperatures in 30 synoptic stations in Iran and 19 synoptic stations in Europe were used for the identical statistical periods of 50 years (1950-2010). The years and days with a minimum of ±0.2 score in 70% of stations and the average of ±0.5 for the sum of stations in those years and days were selected as samples for examination. After processing the data, a total of 220 cold and 117 hot days were extracted. Principal Components Analysis (PCA) and hierarchical clustering was used as techniquesto determine the synoptic patterns of warm and cold periods. Due to the similarity of patterns,

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finally 6 overall patterns were obtained for the cold cycle and 5 overall patterns for the hot cycle. Finally, the data for Earth surface temperature, sea level pressure, geopotential height, and V wind were received and the synoptic maps were prepared and interpreted.

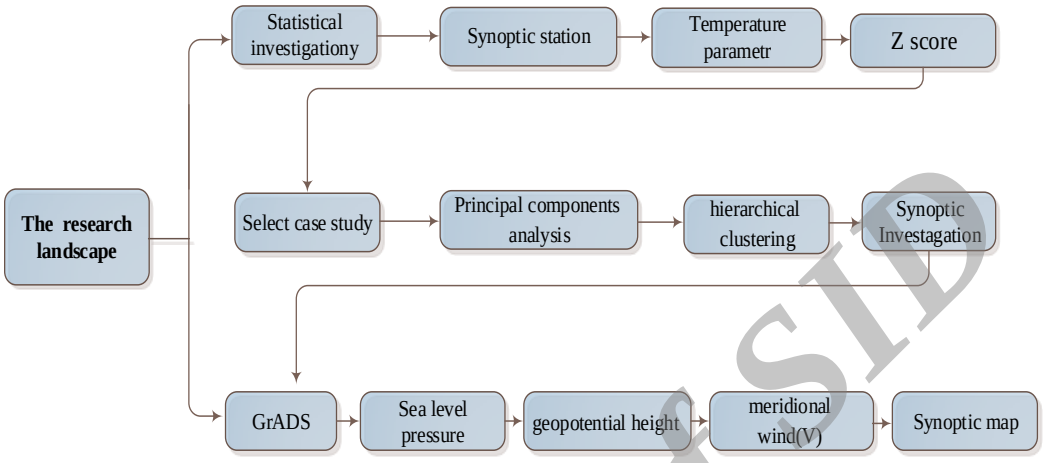

Fig. 1. Steps of the Research Process

Results and Discussion

Statistical analysis of the average temperature data for the study period indicates some different situations. These situations are: 1) identical cold period in Iran and Europe, this cold period is more visible between 1956-1976, 2) identical hot period for Iran and Europe, one of the hot periods with a suitable hot sequential is between 1998-2010, 3) the period of hot Iran and cold Europe, recorded in 1963, 1970, and 1987, 4) the period of cold Iran and hot Europe, observed in 1983, 1989, and 1992. In the results, the year 1972 was identified as the coldest and 2010 as the hottest year for Iran in the study period. Based on the obtained data from the principal component analysis and clustering, six overall patterns were obtained for the cold period, with highest frequency in Omega blocking (19) and Europe stack (12). Blocking system disrupts the normal flow of west winds, and turns tp dominate flows from U to V states. As a result, the location of blocking system plays an important role in creating atmosphere patterns and climate conditions in the affected areas. Generally, in cold periods, turning of west winds to V winds as a result of the dominance of identified patterns has caused advection and falling of cold air in the shape of North flows to the region under study with temperature records lower than average. In hot periods, based on the results of clustering, factor scores and combination of similar patterns, finally 4 atmosphere patterns were identified which led to strengthening of the subtropical high pressure belt on Iran, with two patterns of Europe stack (14) and north position of subtropical high pressure belt (12) with highest frequencies. The abnormality of west winds and their meridional blowing helps advection of hot air in the back of stack and the front of west trough and also meridional direction and strengthening of the subtropical pressure, with temperature records higher than usual. Moreover, it has increased the retreating of west winds, movement and positioning of high pressure belt over summer over northern latitude of the region.

Conclusion

Although climatic conditions of any region are affected by various factors and also different from its surrounding areas, some climate phenomena of same origin can operate at a larger scalein different areas. The present study aims at determining the identical synchronic temperature cycles in Iran and Europe according to synoptic patterns. To achieve this goal, temperature data of synoptic stations in Iran and Europe and data of various atmosphere paterns were used. Processing of the temperature data of the selected stations in Iran and Europe indicates identical/synchronized and opposing temperature cycles between the two regions.

Processing the temperature data in Iran indicates the frequency of cold cycles in the past and significant increase of hot years in the recent decades especially between 1990 and 2010,. Thus, 1972 was identified as the coldest and 2010 as the hottest year during the study period. Synoptic results show that formation of blocking systems and their movement in west wind contours was the main cause of cold cycles. In cold cycles under study, positioning of the region under study in the eastern part of Omega blocking and positioning of a strong stack over Europe and movement of west wind contours and their stretching towards upper width can lead to movement of cold air in the upper width to Iran region. In hot cycle, fostering and expansion of subtropical high pressure centers and belts play an important role in shaping hot abnormal cycles. Synoptic maps during hot cycles indicate the progress of subtropical high pressure belt in U and V directions. Unusual movement of the system contours to north widths in addition to pushing back the west winds by hot air advection in lower width has caused hot years in the region under study.

Keywords: ***advection, blocking, principal component analysis, subtropical high pressure, temperature patterns.***