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Time Series Analysis of the Pressure of the Synoptic Pattern Centers Affecting on Seasonal Precipitation of Iran

Dr. Ali Akbar Rasuly
Professor of Natural Geography
University of Tabriz

Dr. Iman Babaeian
Assistant Professor of Climatology
University of Tabriz

Dr. Hushang Ghaemi
Professor of I. R. of Iran
Meteorological Organization

Dr. Peyman ZawarReza
Profassor of Environmental Research Center
University of Canterbury, Newzealand

Introduction

Iran has a variable and very complicated climate: hot and dry in Central deserts, Monsoonal rainfall in South East regions, Dry and Cold in Northern boundaries and wet and mild in Caspian Sea beaches. Generally, about 70 percent of the average rainfall in the country falls between November and March. Rainfall varies from season to season and from year to year. Precipitation is sometimes concentrated in local, but violent storms causing erosion and local flooding, especially in the winter months. A small area along the Caspian coast has a very different climate; here rainfall is heaviest from late summer to mid winter but falls in general throughout the year. Geographical conditions of Iran has great differences, so that besides the two high mountain chains of Alborz in the north and Zagros in the west, there are areas with low elevation at Caspian sea and center of Iran named Dasht-e Lut and Dasht-e Kavir. Across Iran, mean annual precipitation varies from less than 50mm in Central desert area to above 1500mm in South West of Caspian Sea.. The center of Iran consists of several closed basins that collectively are referred to as the Central Plateau. The eastern part of the plateau is covered by two salt deserts, Dasht-e Kavir (Great Salt Desert) and the Dasht-e Lut. There is a permanent salt lake, Lake Urmia in the northwest of Iran. The presence of different topographic condition and vegetation cover has made different climatic conditions in different parts of Iran. The studies of different researchers show that the most important effective synoptic systems on Iran climate are high pressure of Siberian and low pressures of Mediterranean, Sudanese, Black sea and Monsoon. When strengthening Monsoon system in summer season, a secondary system from low pressure of Monsoon is formed on Persian Gulf which is the continuity of Indian Monsoon. In this study, by using the data of medium sea pressure level of American meteorology and oceanography, the time series of central core pressure of the said systems will be analyzed and studied.

Research Methodology

In this research mean sea level reanalysis data have been downloaded for the period of 1948-2009 from National Oceanic and Atmospheric Administration (NOAA). Regarding to the significant controlling role of Siberian high, Mediterranean, Sudanese, Black Sea and Monsoon lows on the climate of Iran, time series of central pressure of the above mentioned weather systems are extracted for each seasons and years under study. For high pressure weather system, maximum amount of the MSL and for low pressure systems the minimum amount of low pressure are calculated using GrADS analysis display software. For Monsoonal low, only summer MSL is extracted because of dominant activities of the Monsoon in summer. Time series of Siberian high, Mediterranean, Sudanese and Black Sea low in winter and spring are calculated as well. Mann-Kendal non-parametric method is used to check any probable change or trend in the synoptic weather systems affecting Iran from 1948-2009. Then the year of significant change in mean sea level pressure is computed by drawing u_i and $u_i^{'}$ series.

Discussion and Results

Using Man-Kendal test and statistics and u_i and $u_i^{'}$ statistics, trend in time series of all weather systems affecting Iran and point of change have been determined.

Siberian high pressure: There were no significant change in winter time series of Siberian high, but strengthening trend in spring time Siberian high is significant in 95% significant level and point of change is 1974. Strengthening of spring Siberian high pressure can increase the amount of precipitation.

Black Sea low pressure: Generally, Black Sea low is a weak low pressure system among all dynamical weather systems affecting Iran. Usually, Black Sea can signify the cyclones passing the Sea toward the east. Man-Kendal test shows that there are significant trends both in winter and spring time series of the systems from 1948-2009. Points of trend are 1978 and 1979 in winter and spring.

Mediterranean low pressure: Mediterranean Sea is one of the important regions of cyclogenesis in Middle East. Cyclones usually pass southern part of Mediterranean Sea in February, but their tracks display to the northern part from December to January. Regarding to the many researches done by Iranian scientists, Mediterranean lows have the most weather system that controls Iran climate, especially in the western region. Analysis of 61 years reanalysis pressure data confirm that central pressure of the system has been filled by 3.9 and 2.4mb in winter and spring, respectively, meaning that the cyclogenesis activities has been weakened. Changes in pressures time series are significant in 95% confidence level.

Sudanese low pressure: Sudan low is an active system both in warm and cold seasons. It has thermal behavior in summer and brings hot and dry weather to the Arabian Peninsula causing dusty climate. It is a dynamic low pressure in winter and brings humidity to the Arabian Peninsula and south of Mediterranean Sea in cold and rainy seasons. When combining with Mediterranean low, an active and deep combined low forms between Mediterranean Sea and Alborz mountain range of Iran. Usually plateau of Iran experiences heavy rainfall during combined Sudanese and Mediterranean lows. Our results show that during the period of study the central pressure of Sudanese low has been weakened by 2 and 0.5mb in winter and spring.

Monsoon and Persian Gulf lows: Indian Ocean and Oman Sea have significant effect on the climate of Iran in summers, especially in the southeastern regions. Usually trough of Inter-Tropical Convergence Zone is elongated toward Persian Gulf in summer, bringing tropical hot and humid air-mass to the region. Statistical tests and trend analysis confirms that central pressure of Monsoon over Pakistan and Persian Gulf low has been decreased by 3.8 and 1.2mb, respectively.

Conclusion

Statistical behavior of the main synoptic weather systems affecting Iran's climate including Siberian high, Mediterranean low, Sudanese low, Black Sea low, Monsoon and Persian Gulf lows are assessed in this paper during 1948-2009 by using NOAA reanalysis pressure data. Statistical test of Man-Kendal and trend analysis were assessed on time series of the central pressure of the weather systems affecting Iran. It is shown that the central pressure of the main weather systems affecting Iran is weakened. There was no significant change in Siberian high pressure in winters, change in spring time series is significant at 95% confidence level. Weakening of Mediterranean low are 3.9 and 2.4mb in winter and spring. Both of changes are significant. Black Sea low is expected to decrease by 3 and 4mb winter and spring and Sudanese low has been decreased by 2 and 0.5mb.

Keywords: Sea level pressure, Time series, Trend, Mann-Kendal test, Seasonal precipitation of Iran.

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