

The Relationship between Circulation Pattern Types in Sea Level Pressure and Precipitation in Iran

Ghasem Azizi*

Associate Prof. in Climatology, Faculty of Geography, University of Tehran, Iran

Teimour Alizadeh

PhD Candidate in Climatology, Faculty of Geography, University of Tehran, Iran

Received: 15/07/2013

Accepted: 24/05/2014

Extended Abstract

Introduction

The recent developments in computer sciences have considerably affected the application of new methods in climatology. Especially these new technologies have increased the usage of the new methods in climatic classification. The previous classifications were calculated only based on insufficient number of climatic factors. For example, the well-known classification of Koppen was based on precipitation and temperature. In contrary to such threshold-based classifications, the implementation of multivariate statistical techniques has allowed to classify climate without predefined thresholds by grouping individual objects by Jacobeit (2010) methodology. Application of multivariate analysis in climatology is conducted by Yarnal et al (2001). The aim of this paper is to use the classification technique and recognize the circulation patterns at the sea level and their connection to variability of precipitation in Iran. To obtain a comprehensive view of the precipitation in Iran and its effective factors a number of the researches are conducted. Many papers have investigated the main circulation and air masses as effective factors on Iran precipitation. However, there is not an agreement among them and the main disagreement seems to be about the methodology. Khoshhal (1997) using synoptic analysis studied the greater than 100 mm precipitation in coastal area of Caspian Sea. He showed that in contrast to the previous studies, the cold advection of the Siberian anticyclone over Caspian Sea is not the main reason for forming the heavy precipitations and these events are connected to the entrance and settlement of anticyclone and cyclonic systems. Applying the

*E-mail: ghazizi@ut.ac.ir

Tel: +98 9123841192

vorticity calculation, Alijani (2003) identified the rainy air masses in Tehran. He concluded that the effect of 500 hPa level is stronger than other levels and the cyclonic circulation type creates the heavier precipitations.

Methodology

There are two main approaches in synoptic climatology: the environment to circulation and circulation to environment approaches. Because of the high variability of precipitation, researchers used the environment to circulation in their studies (Yarnal, 1993). As a result, the environment to circulation approach is used in this paper as well. The mean daily precipitations of synoptic stations of Iran were collected for the time period of 1980 - 2009. The distributions of these stations are shown in Fig 1. Then the point data were interpolated with cell size of 0.057° grid point (5.9×5.9 Km). Totally a number of 46939 cells were calculated and an $n \times p$ matrix was created. Where n refers to the days (10958 days) and p refers to the spaces (46939). Using this matrix in daily basis, the Percent area, Mean and maximum precipitation for all area of Iran were calculated. To eliminate the local precipitation and considering only the extensive precipitations, two conditions were defined: the average precipitation of Iran must exceed 1 mm, and over 40 percent of Iran area must receive precipitation. Accordingly, a number of 1548 days of extensive precipitation in the course of study area were recognized. For explanation of the circulation patterns of these events, mean sea level pressure, in a scale of $2.5^\circ \times 2.5^\circ$ grid point, NCEP/NCAR reanalysis data from 0° to 100° eastern longitude and 10° to 80° north latitude were collected and a 1548×1189 matrix was created. The Principal Component Analysis (PCA) was used in order to reduce the volume of the matrix. Many researchers have used the PCA and its application in multivariate analysis.

Results and Discussion

The results of PCA over the extensive rain matrix of Iran are shown at table 1. As it can be seen in the table, a number of 48 eigenvalues greater than one which explained 92% of the total variance was obtained. Among these, 15 factors that explained more than 1% of whole the variance were selected. These factors explained 88% of the total variance. Load factor matrix score is the matrix that has a 1548×15 dimension.

Conclusion

In this paper, the connection between circulation patterns on sea level and Iran precipitation was analyzed by applying environment to circulation approach. For this purpose, the daily grid point precipitation with 5.9×5.9 Km dimension obtained 1548 days, with considering a condition that at least precipitation in Iran must be 1 mm and also 40 percent of Iran area must receive the precipitation. Sea level pressures of these days were selected for identification of the main type of the circulation patterns. The (PCA) technique was used for reduction data and with cluster analysis it obtained 5 main circulation pattern types.

The investigation of the relationship between the circulation patterns and the precipitation

events revealed that there are five distinctive precipitation patterns in Iran. These types are including:

- Type 1: Interaction between Sudan low pressure and Siberian anticyclone;
- Type 2: combination of Mediterranean low pressure -Sudan low pressure and interaction with Azores and European anticyclone;
- Type 3: interaction between Sudan low pressure and European high pressure tongue;
- Type 4: Interaction among Tibet high pressure, Azores high pressure, and polar low pressure;
- Type 5: Thermal low pressures and Indian monsoon system.

Keywords: *Atmospheric Pattern Classification, Low Pressure Dynamic, Principal Component Analysis, Siberian High Pressure.*

Archive of SID