Dynamical- synoptical analysis of summer precipitation process in Southeast Iran

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Extanded Abstract

Introduction

In Iran plateau, with movement of the subtropical high pressure to low latitudes in cold period of year, the emigrant systems of westerlies are dominant atmospheric phenomena in this region and control atmospheric phenomena in this period of year. But in the warm period of year the Sub-Tropical high-pressure is dominant atmospheric pattern in higher level of atmosphere in the Iran plateau. It is the main factor that controls the weather and climate over this region in the middle and lower troposphere as a local to regional scale thermal forcing. Focusing on the source and the path of necessary humidity for summer precipitations in this region, Parand (1991), Alijani (1995) and Najarsaliqe (1998) believed that the humidity of Indian Ocean and Arab Sea in low pressure cyclonic circulation of Pakistan move parallel through southern feet of Himalaya Mountain and penetrate southeast Iran in an east- west direction from Pakistan. In case of existing necessary factors, they ascend and make summer precipitations of the region.

Materials and Methods

The period used in this study was 78 days in 22 years (2010-1982) from May until end of September. The atmospheric circulation was extracted using daily mean of the 850 hPa geopotential height. Then, the agglomerative hierarchical cluster analysis with the ward

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algorithm and Euclidean distance are used to identify atmospheric circulation types over Iran in mentioned period of years. Then, we calculated the within-group correlation to identify representative days. The day with the highest within-group correlation was representative day of atmospheric circulation types. Finally, 4 atmospheric circulation types were identified for this summertime precipitation. Humidity flux divergence of the region was calculated by the relationship called horizontal flux divergence, in which in x,y directions (longitude and latitude), (q) stands for small changes of specific humidity, (u) for U component wind, (v) for V component wind.

$$HFD_{ij} = -\left[u_{ij}\frac{q_{i+1j}-q_{i\ 1j}}{x_{i+1j}-x_{i\ 1j}} + v_{ij}\frac{q_{ij+1}-q_{ij\ 1}}{y_{ij+1}-y_{ij\ 1}} + q_{ij}\frac{u_{i+1j}-u_{i\ 1j}}{x_{i+1j}-x_{i\ 1j}} + q_{ij}\frac{v_{ij+1}-v_{ij\ 1}}{y_{ij+1}-y_{ij\ 1}}\right] \quad (1)$$

HFD is horizontal flux divergence, but ∂_x and ∂_y stand for the distance in longitude and latitude, respectively. Besides, positive values mark humidity flux convergence, while negative values show humidity flux divergence. In fact, calculated values are dedicated to each level considering the values for special level, as a result, to find the real values of humidity flux for vertical sum. This value should be calculated for the distance of the height level of atmosphere. Following relationship is used in which (vq) stands for HFD, (p) for the level of atmosphere at geo-potential height, and Qvi for vertical sum of humidity flux.

$$Q_{vi} = 1/g.\int_{p^1}^{p^2} vq.dp \quad (2)$$

Since the used data are 6-hour, these calculations are done for a 6-hour period. To do the aforesaid calculations for a longer period (2 day) and the distance between several atmospheric levels following equation should be used. In this equation, (t1) and (t2) stand for the beginning and end times of calculating, respectively.

$$Q_{vi} = \int_{t1}^{t2}.\left(1/g.\int_{p1}^{p2} vq.dp\right).dt \quad (3)$$

Results and Discussion

Focusing on these precipitations, 4 patterns were recognized. The humidity flux was studied through 3 levels of atmosphere (lower levels, higher levels and vertical profile of atmosphere). There is a core of humidity flux convergence in southeast Iran in lower levels of atmosphere (1000-750 hPa). Besides, cores of humidity flux divergence on north of Arab Sea, west of Arab Sea and Persian Gulf are responsible for injection of humidity to surrounding regions. A core of humidity flux divergence is also formed in southeast Iran in middle and upper levels of atmosphere. Therefore, the injection of these precipitations happened in lower levels of atmosphere. Vertical profile of atmosphere revealed that, among the patterns, there is humidity flux convergence from the surface to 750 hPa level and humidity flux divergence in upper levels.

Conclusion

Study on summer precipitations of southeast Iran revealed that a tongue from Gang low pressure in 1000 and 850 hPa levels penetrate Iran Plateau and Arabian Peninsula, while there is no tangible trace of this low pressure on the region in 700 hPa level. The calculation of humidity flux function is in accordance with the findings of Karimi et al. (2007). Besides, north part of Arab Sea is obviously considered as the most important source of humidity in the region, as a core of humidity flux convergence is made in all patterns from the earth surface to 750 hPa level. Three cores of humidity flux divergence on north part of Arab Sea, west part of Arab Sea and Persian Gulf transfer humidity to surrounding regions. The divergent core of north of Arab Sea and west of this sea are considered to be the most important source to provide humidity for the region, while the core of Persian Gulf is minor. This phenomenon is mainly the result of central and southern Zagros Mountain chains which limit transformation of humidity from Persian Gulf to Iran Plateau. Moreover, there is no core of humidity flux divergence on Oman Sea to transfer humidity to surrounding regions. On the other hand, counter clockwise circulation of air through southern feet of Himalaya Mountain Chain in lower levels of atmosphere can only be seen in pattern 4 (Fig. 4) and slightly in pattern 3 (Fig. 3). Such synoptic order has no role in providing the needed precipitation humidity of southeast Iran, for it is too far from southeast Iran to provide enough humidity. Moreover, a strong core of humidity flux convergence is made in north part and center of Pakistan in which the aforesaid circulation in southern feet of Himalaya penetrates into the area. The atmosphere of the study area can be divided into lower part (1000-750hPa level) and upper part (700- 300 hPa level) through humidity flux convergence and humidity flux divergence, respectively.

Keywords: dynamic, Gang Low, Souteast Iran, summer precipitation, synoptic.