Synoptic Investigation of the Role of the Sudanese Low Pressure System during Wet and Drought Years in the Southern Half of Iran

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1. Introduction

Variability and changes in precipitation amounts, including extreme precipitation and droughts, trigger relevant societal and environmental impacts. Atmospheric circulation strongly determines precipitation variability over southern half of Iran. The influence of prevalent synoptic situations on the distribution of precipitation amounts needs to be understood, as well as their frequency changes to appraise the impact of atmospheric circulation on intra- and inter-annual (decadal) fluctuations of precipitation amounts.

On the other hand, the atmospheric moisture budget plays important role in the hydrology of this region. The aridity in the southwest and south of Iran is due to subsidence scale caused by Hadley circulation and a location far from oceanic sources of moisture. However the moisture and other properties of atmospheric quantities are transferred by local circulation from another source to the given region. Many investigations have been carried out on this subject. The consideration of the precipitation and its source region of moisture flux over south and southwest of Iran, during 1970-74 has been shown that 23 percent of the total low pressure system which passed over this area are from the southwest of the Red Sea (Faraji, 1982). In the investigation of moisture flux over Iran, which is carried out by Alijani (1995) noted that the Mediterranean Sea is the main source of moisture for precipitation over Iran. Evans, Smith & Oglesby (2004) have shown that the Persian Golf and the Caspian Sea are the main sources of moisture for precipitation over the Alborz and the Zagros mountains. They have shown that the subtropical jet current brings the warm and moist air from the South part of Saudi Arabia and the Aden golf to the Middle East in the middle and higher troposphere (Dayan &Abramski, 1983).

The Red sea inverted trough at the surface with regard to its amplitude, is the Major source that transfer warm and moist air from the Aden golf to the East and North of the Arabian peninsula and also southwest and south of Iran (Alpert, 2001). The low pressure system which is formed at southwest of the Red sea is associated with high potential acceptability of moisture and warm air due to its characteristics of dynamical

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and thermo dynamical pressure for heavy rainfall over the study area. Rurerde (2006) using specific humidity map and its extension from the Caspian Sea to the North part of Iran derived a value of moisture quantities from each source region of moisture to the precipitation over Iran. The principal objective of this research was to understand the characteristics of moisture flux from each region of moisture source and their contribution to the rainfall during the above period.

2. Study Area

The study area for this study is southern half of Iran, which lies approximately between 25N and 35N in latitude and between 44_E and 64_E in longitude. The study area of this research contains some provinces such as: Ilam, Khozestan, Lorestan, CharmahalBakhtiyari, Kohkiloye and Boyerahmad, Bushehr, Esfehan, Yazd, Kerman, Hormozgan, Fars, and Khorasan Jonobi. Based on the Koppen climate classification, most parts of this area are categorized as generally having arid (BW) and semi-arid (BS) climates. The important mountain of this area is the Zagros, which play an important role in nonuniform spatial and temporal distribution of precipitation.

3. Material and Methods

Examination of precipitation properties needs long and high quality records of data. In the present study, the time series of precipitation data at 183 stations for the period 1974-2004 were collected from the Islamic Republic of Iran meteorological organization (IRIMO) and were analyzed. Data homogeneity is assessed by IRIMO previously. The Empirical orthogonal function (EOF) was applied to detect and describe spatial and temporal change in the precipitation. In addition, the principal component (PC) was applied to detect dry and wet years.

In addition, to identify the spatial and temporal variations of the precipitation, we used the NCEP-NCAR reanalysis monthly mean values of the temperature, Geopotential height and pressure in 1000, 850, 500 and 300 hPa levels. These data have been widely used by many researchers over the last few years in tropical climate research. Finally, we calculated 30 years anomaly for these levels in dry and wet years.

4. Results and Discussion

The maps of the wettest months have shown the synoptic situation over study and its adjacent area during the above period. These figures have show the high pressure over the Oman and the Arabian seas, deep trough over the East of the Mediterranean and the west of the Red sea.

In this case, eastern Saudi Arabia received more moisture and latent heat fluxes than the other parts of the area. Two moisture source regions as observed from the divergent flux, which are located over the Aden golf and Red sea, supply moisture to study region. Southern half of Iran receives precipitation during this study, mainly from the west of the Indian Ocean (the Arabian Sea, the Oman Sea, The Aden golf), the Red sea and the some extent from the Mediterranean. The divergent moisture and latent heat flux during wet cases were observed over north part of the Arabian Sea, the Aden golf, the central part of the Red sea and convergence was observed over South, central of the

Arabian Peninsula, southern half of Iran. These processes are indicative of the upward motion of moist air, which in turn may release latent heat due to condensation. This available heat energy may be the source of low-level latent heat instability. The large amount of moisture and latent heat flux over Saudi Arabia in is transported, by rotational wind from the Red sea and the Mediterranean as mentioned above.
Conversely, in dry years due to weak trough of East Mediterranean, systems move from latitudes upper than 40ºN and the cold air does not transfer from the southeast Europe to the Northeast of Africa resulting development of Sudan low. Overall, decreasing transfer of cold air will lead to decreasing of moisture and latent heat flux from the Indian Ocean to the southern half of Iran.

5. Conclusion

Atmospheric circulation strongly modulates precipitation patterns. Precipitation is one of the most important atmospheric variables in the global hydrological cycle and plays a key role in the Earth's energy balance.The investigation of synoptic maps in 1000, 850 and 500 hPa levels in four systems shows that in wet years due to deep trough of East Mediterranean and West of the Red Sea, the cold air transfers from the southeast Europe to the Northeast of Africa resulting development of Sudan low. This low transfer to the center and north of the Arabian Peninsula, then move to the Southern half of Iran. The development of this low is due to release of sensible heat from the Arabian Desert and latent heat flux which transfer from the Indian Ocean, to this area. This low affects the southern half of Iran with significant value of perceptible water and low- level latent instability. It is seen that the transfer of moisture flux in the low-layer from the Indian Ocean plays an important role in precipitation over study region. Conversely, in dry years due to weak trough of the East Mesiterranean, systems move from latitudes upper than 40ºN and the cold air does not transfer from the southeast Europe to the Northeast of Africa resulting development of Sudan low. Overall, decreasing transfer of cold air will lead to decreasing of moisture and latent heat flux from the Indian Ocean to the southern half of Iran. The findings of this study confirmed the results of the previous studies (Alijani, 1995; Farajzadeh, 2007;Milind, 2006; Mofidi&Zarin, 2005).

Keywords: Synoptic investigation, Sudanilow pressure, Wet and drought years, Southern half of Iran.

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