Detection of Geo-potential Height Changes, Vorticity and Sea Level Pressure of Prevailing Circulation Atmospheric Patterns Impacting Iran Climate

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Extended Abstract

Introduction

The changes in behaviour of climate and meteorological parameters are closely related to changes in atmospheric circulation. The analysis of historical atmospheric troposphere circulation is critically important to global and regional climate change and extremes with regard to its dynamical features. The circulation changes are manifested by a gradual reduction in high-latitude sea-level pressure, and an increase in mid-latitude sea-level pressure associated with one phase of the Arctic Oscillation (a hemisphere-scale version of the North Atlantic Oscillation. Recent observations have found that the tropical belt running around the equator has grown wider, and has expanded by around 2° to 5° latitude and into the adjacent subtropical regions since 1979. Global greenhouse gas emissions contribute to expansion of the tropics (about 0.05° per decade)in the northern hemisphere tropics. The effect of black carbon and troposphere ozone emissions are about twice the size of those due to greenhouse gases alone (about 0.07° to 0.12° per decade). The aim of this study is investigation of variability in the intensity of the monthly geo-potential height, vorticity and sea level pressure over synoptic circulation patterns impacting Iran.

Methodology

In order to accomplish this research, daily grid data with spatial resolution of 2.5×2.5 degree during 1/1/1960 to 31/12/2012 have been extracted from NCEP/NCAR database. The monthly average sea level pressure and geo-potential height in level of 1000 hectopascal is calculated to

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detect the action of spatial kernel of each synoptic system. The for this investigation is including daily zonal and meridian wind components (Uwnd and Vwnd) data, geopotential height data for each levels of 1000, 850, 700 and 500 hectopascal levels, and sea level pressure. Vorticity is calculated by Uwnd and Vwnd components. Then monthly mean is also calculated for each levels separately. Although some circulation patterns can operate in special months and seasons of year but trend analysis has been evaluated for each circulation patterns in whole months and seasons. To detect time series trend, nonparametric Mann Kendal statistic test has been applied. The trend has been tested in 95% confidence level. Sen Estimator is used to calculate trend slope rate.

Results and Discussion

Siberian anticyclone, Sudan cyclone, Mediterranean region cyclones (East Mediterranean, Mediterranean and Black sea) and Monsoon and Persian Gulf cyclones have been selected according to the maps of sea level pressure and geopotential monthly means. In total vorticity, geopotential height in different levels and sea level pressure have significant trend in 95% confidence level. The highest variation is observed for high levels at 700 and 500 hectopascal. In winter season, sea level pressure, vorticity and geopotential in 1000, 850, 700 and 500 hectopascal levels don't show significant trend. While in spring and summer the trend of vorticity in four selected levels is significant and negative, geopotential height and sea level pressure have positive significant trend. Over cyclonic systems in Mediterranean region, the sea level pressure and geopotential height show increasing trend especially in winter season. The slope positive trend on the Sudan is significant in winter. The trend of geopotential height in four selected levels in winter is positive and significant. In other seasons, the trend is positive except in 1000 hectopascal level. Over Monsoon cyclone system in all seasons, geopotential height is increasing from 1000 to 500 hectopascal levels. Vorticity trend in low levels at 1000 and 850 hectopascal is positive. The increasing geopotential height over Persian Gulf is smaller than other atmospheric circulation patterns especially in low levels. Vorticity rate contrary to other systems is increasing.

Conclusion

Increasing sea level pressure and geopotential height over cyclonic circulation patterns of Sudan and Mediterranean regions especially in cold seasons of year (winter and autumn) result in a decrease in systems cyclonic action, sea level gradient pressure, instability and precipitation in region. In warm seasons of year (spring and summer) negative trend of vorticity and positive trend of sea level pressure and geopotential height result in decrease in warm seasons precipitation and increase in stability. The results of this study agree with findings of some other researchers about increase in warming of troposphere, changes in synoptic systems intensity, instability increase and negative vorticity increase in north hemisphere.

Keywords: ***Geopotential Height, Iran, Sea Level Pressure, Synoptic Systems, Vorticity Changes.***