Trend and Oscillation Analysis of Water Vapor Pressure in South and Southwestof Iran

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1. Introduction

Identification and analysis of time-series behavior of the climatic elements and processes upon them are the basic factors of climatology science and has an important role in management and environmental planning. In general, the behavior of climatic elements is observed in 3 forms: Trend, Oscillation and Fluctuation. These behaviors will help us to identify climate change better. Today by changing more the trend of climatic elements, climate change has become more important than previous years. But in between the climatic elements, it has been noticed less than the other elements such as water vapor pressure. The importance of water vapor is that this climatic parameter has an important role in explaining the climate change, because of 1) It is the main source of rainfall in all weather systems, 2) It supplies the latent heat in this process and controls the heat in the troposphere and 3) It is the intensify severe storms. Given the significant role of atmospheric moisture in the Earth's energy equilibrium, it can be helpful in explaining climate change. Therefore, this article tries to survey two time series behaviors of climate data; the trends and fluctuations in water vapor pressure. The Mann-Kendall test is one of the popular nonparametric techniques for explaining the trend analyzing in hydrological and climatic data. The spectrum analysis is one of the best methods for extracting and analyzing visible and invisible climatic oscillations with different wavelength. In fact, spectrum show the distribution of variance along the entire range of wavelengths in time series. So in this article, we want to analyze the trend by using the Mann-Kendall test and detect and identify the fluctuations and cycles of water vapor pressure time series by using the spectrum analysis.

2. Study Area

The study area, with about 360,200 km^2 area, is located in the south and southwest of Iran and approximately between 25° 00'N and 34° 25'N latitudes and between 45° 38'E

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and 59° 17'E longitudes. Southern and southwestern parts of the study area is located in sides of two massive sources of moisture, Persian Gulf and Oman Sea.

3. Material and Methods

In this study, water vapor pressure data from 28 synoptic stations, during a period of more than 20 years in south and southwest of Iran were used that were collected by the Iranian Meteorological data website (http://www.weather.ir). It should be noted that to survey the Mann-Kendall test and Spectral analysis, the stations with 44-years period (2010-1967) and stations that have data since their establishment were used, respectively. The methodology of this study is detecting trends and oscillation of water vapor pressure in south and southwest of Iran by Mann-Kendal test and Spectral analysis, respectively based on ground station. Tests for the detection of significant trends in climatological time series can be classified as parametric and non-parametric methods. Parametric trend tests require data to be independent and normally distributed, while non-parametric trend tests require only that the data be independent. In this study, a non-parametric method, Mann-Kendal, was used to detect trends. To analyze the Oscillation of water vapor pressure, the spectral analysis has been applied. In this function, frequency and cycles indicate the time scale and amount of variance in the time scale, respectively. After extracting all waves, in second step the proportion of each waves in explaining the total variance are specified and Finally, the significance of each waves are tested. For performing the Mann-Kendall test and spectrum analysis technique, the capability of programming in MATLAB software was used.

4. Results and Discussion

The results showed significant trend in most of the stations. As the results of this article, the downward significant trend in the stations of Ahwaz, Bandarabas, Shahrekord, Boroujen, Abadeh and Khorramabad, the upward significant trend in Lengeh, Bushehr, Dezful and non-significant trend in Abadan, Fasa and Shiraz was seen. By applying the spectrum analyzing in 95% confidence level on the water vapor pressure data, the multiple cycles were obtained; So that the significant sinusoidal cycles 3-2, 4 and 15-7 years were more common. Results show that the cycles of 3-2 years was most repeated in the water vapor pressure time series. 4-year cycle was the other cycle of events occurred in the study area that researchers have attributed this cycle to ENSO. The survey showed that more cycles are traceable in the southern part of the Zagros. Another cycle in the region was 15-7 year cycle that most scientists have attributed this cycle to sunspot activity. The final survey showed the plurality of cycles in the West and South West of the study area.

5. Conclusion

In general it can be concluded that the downward significant trend of water vapor pressure was observed in the Zagros and the upward significant trend was observed in nearby the Persian Gulf. By applying the spectrum analyzing on the water vapor pressure data, the multiple cycles were obtained. Results of spectral analysis showed that the cycles of 3-2 years was most repeated in the water vapor pressure time series.

The spatial distribution of this cycle was observed in the near of Persian Gulf coasts. Most scientists have attributed this cycle as a result of El Niño - Southern Oscillation (ENSO) and Quasi-biennial oscillation (QBO).

Key words: Water vapor pressure, Trend, Oscillation, Mann-Kendal, spectrum analysis.

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