Study of Sensible Heat Flux and its Relationship with Temperature Changes and Wind during Warm Periods of Year in Iran

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Extended Abstract

Introduction

Changes in the Earth radiation balance not only affects the physical and ecological variables, but also disturbs the ecological balance, especially in arid and semi-arid regions. The energy budget in the earth surface is measured with flux content for the ideal surface. The flux is defined as the amount of matter passing through the unit of area in the unit of time with vertical direction. There are four types of energy fluxes at an ideal surface, namely the net radiation to or from surface, the sensible heat fluxes to or from the atmosphere, latent heat flux to or from the atmosphere, and the heat flux into or out of sub surface (water or soil). The net radiation flux is the result of radiation balance at the surface. The changes of surface sensible heat flux has a great impact on local and remote climate variability and climate hazards such as dust storms, particularly in warm months. Several studies have led to a good understanding of the changes of surface fluxes. For example, Zhou and Huang (2009) investigated the changes of heat flux in arid and semi-arid regions of northwest China and its relationship with summer precipitation in China. The results showed that any change in spring heat flux in northwest China in the east of Asia affects the summer precipitation. There are many researches in Iran, (Zare, 1999; Khalili 1997, 2002; Sadrinasab & Meyvand, 2010). For example, studying the thermal energy balance in Persian Gulf, Rais-Alsadat and Rais-Alsadat (2012) concluded that according to precipitation, evaporation and the volume of the water in and out of the Persian Gulf, the net heat transferring

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in this area is about 25 w/m^2. This extra heat can be justified by surface heat fluxes. Although, there are limited studies about heat flux changes in Iran, the changes of temperature and wind speed have been investigated in different aspects (Masoodaian, 2004; Zahedi et al., 2007; Ghahreman & Gharakhani, 2010). For example, Danesh Kararasteh (2007) studied the process of temporal and spatial changes of temperature and precipitation in Iran by applying remote sensing. He determined the affected climatic regions. The results revealed that the uptrend on monthly temperature mean affects the precipitation trends in north-northwest and south-southeast rain regions. As a matter of fact, the necessity of having a long-term time series to show heat flux changes in the areas with limited coverage of stations indicates the importance of applying reanalyzed data. Using these kinds of data, Roshani et al. (2014) analyzed temporal-spatial changes of the net radiation flux over a long time in Iran. They concluded that not only yearly changes of net radiation flux have sinusoidal behavior, but also monthly changes are influenced by the change in radiation angle, the general circulation and local phenomena.

Materials and Methods

Sensible heat flux of Iran was calculated based on the data of air temperature, land temperature and wind speed obtained from reanalysis of the data during a 34-year period (1980-2014) for a limited area (43^o to 64.5^o eastern longitude, 20^o to 41^o northern latitude). In this study, sensible heat flux was calculated for warm months (spring and summer) by using the bulk formula. Moving average and anomaly were used to consider the changes of monthly and seasonal time series of sensible heat flux, temperature and wind speed variables. Linear and polynomial regressions were calculated to determine the trends in every variable. Correlation and multi-variable regression and Pearson correlation coefficient were used to show the relationships between sensible heat flux, temperature and wind speed variables. Excel and SPSS were used to run all the statistical calculations. Finally, the isohyet maps were plotted using GIS.

Results and Discussion

This study aimed at observing uptrend trend in spring sensible heat flux and down trend in summer heat flux. The gradient in spring, (0.18), and summer, (0.039), showed the high intense of variations in spring. Spring sensible heat flux shows positive anomalies in recent years while sensible heat flux in summer shows variations with regular periods and mostly in negative anomalies. Despite the spring precipitation, wet soil, growing vegetation and increase in latent heat flux, North West Iran shows the minimum sensible heat flux and maximum standard deviation. The changes of air temperature and land temperature are increasing during the study period representing the uptrend in seasonal time series. However, the decrease in wind speed makes little trend changes in long-term wind speed in spring and summer. It was found that spring and summer sensible heat fluxes were greater in the 1990s than other decades. All land temperature, air temperature and wind speed displayed an obvious interdecadal increase in 1990s. In addition to west, North West regions, central and east Iran showed maximum standard deviation in sensible heat flux in 1990s. Multi regression was applied for each season separately. The results were in accordance with the results of correlation in the relationship between the variables (land temperature, air temperature and wind speed) and sensible heat flux. Linear R-squared value is 0.49 showing that land temperature can determine 50 percent of sensible heat flux changes in spring. Besides, polynomial R-squared value is 0.19 in wind speed to determine 20 percent of sensible heat flux variations in summer

Conclusion

This study could prove the relationship between maximum sensible heat flux and maximum land and air temperature in west, North West, center and southern part of Caspian Sea. The change in the surface wind speed played a more important role in the interdecadal variations in sensible heat flux during the summer, whereas the change in the land temperature was more important for the interdecadal variations in sensible heat flux in the spring. Therefore, it seems that land temperature in spring can affect the relative humidity, precipitation and drought in summer leading to the occurrence of climatic hazards such as dust storms.

Keywords: climatic elements, Iran, sensible heat flux, variations trend, warm period.