Study on Physical Surface Temperature Patterns in Different Weather Conditions

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Extended Abstract

Introduction

Materials and surfaces with different thermo-physical properties provide variety of temperature patterns and temporal changes. Analyzing thermal behavior of the different land covers is one of the significant factors to determine urban microclimates. Urban land covers have usually high temperature. This can potentially increase the intensity of urban heat island effect and building cooling energy consumption and also change energy balance and heat fluxes in these areas. Therefore, regarding to the impact of surface temperature on changes of surrounding air components and formation of Urban Heat Islands (UHI), the main objectives of this study are including identification of the circadian pattern of surface temperature in different weather conditions and providing the best regression model to estimate surface temperature using air temperature.

Methodology

To determine the surface temperature patterns of different land covers such as Asphalt, Soil, Cement and Stone, three data loggers along with four Platinum Resistance Thermometers (PT100 sensors) were installed in Geophysic Weather Station in University of Tehran.

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Therefore, temperature of these land covers was recorded hourly during the November 2012. Furthermore, meteorological data including air temperature (°C), relative humidity (%), precipitation (MM), and cloudiness (Okta) were gathered from Geophysic Weather Station. Then, circadian temperature pattern of different land covers were selected to be analyzed in six days of November with different weather conditions (Sunny, Cloudy, Rainy conditions). Finally, the best regression model for predicting daily mean surface temperature was provided using air temperature. In addition, two statistical methods such as Nash-Sutcliffe efficiency coefficient and correlation coefficient were used for determining the efficiency of the regression model in estimating the different land covers surface temperature.

Results and Discussion

According to the results, it can be concluded that in sunny and cloudy conditions surface temperature of all land covers increase with sunrise at 6 A.M. (local time) and this trend continue until noon so that, maximum surface temperature occur around 12 P.M. Then, surface temperature decreases because of reducing the amount of solar radiation and finally at sunset, the surfaces lose their heat, obtained during the day, as long wave radiation. It is important to note that in cloudy conditions, the amount of energy absorption during the day and it loses during the night is less than sunny conditions because of cloud cover existence in the sky and the effect of the cloud's albedo. Therefore, in these weather conditions surface temperature pattern has sinusoidal mode but temperature range (difference between maximum and minimum temperature) on cloudy conditions is less than sunny conditions due to cloud cover so that studying relationship between surface temperature and cloudiness depicted that there is inverse relationship between them and temperature reduces when cloudiness increase. It was also illustrated that there is no specific hourly trend in surface temperature in rainy conditions and there are many variations in surface temperature. Totally, on sunny and cloudy conditions the highest temperature is related to Asphalt, Cement, soil and Stone, in order. While on rainy conditions Asphalt has the lowest temperature between the studied land covers because of water flow over the surface. Thus, it can also be concluded that permeability of the surfaces is one of the most significant physical properties in the surface temperature behavior. Land covers which are impermeable (such as Asphalt, Cement and Stone) in rainy conditions show lower temperature because of the water impact. In addition, reconstructed surface temperature data display that there is a significant correlation between observed and estimated temperature using daily mean air temperature, so that correlation coefficient between these two parameters varies from 0.98 to 0.97 and is significant at 0.01% level. Moreover, result of Nash-Sutcliffe efficiency coefficient varies from 0.8232 to 0.9205 which shows proper efficiency of the regression model.

Conclusion

The main objective of this study is analyzing surface temperature of different land covers during the day/night and different weather conditions and also providing a regression model for estimating the surface temperature in these land covers. Generally, this can be concluded that different land covers surface temperature is completely a function of their thermal properties in

calm and sunny weather conditions. Some surfaces such as Asphalt and cement which have less thermal conductivity and high absorbency show the highest surface temperature during the day. While, on rainy conditions both air and surface temperature have many variation because of cloudiness and precipitation. In such conditions some physical properties like permeability of the surfaces play significant role in thermal behavior of land covers. Finally, according to the correlation and Nash-Sutcliffe coefficients it is concluded that regression coefficients between daily mean air temperature and surface temperature have proper efficiency for calculating daily mean surface temperature.

Keywords: ***Land Cover, Regression Model, Surface Temperature Pattern, Weather Condition.***