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Effects of Land Use and Land Use Change on Regional Temperature Variations in Beijing

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Land use/land cover (LULC) changes may have important local, regional and global climatic implications by modifying the underlying land surface conditions which in turn change the exchange of energy and moisture between land surface and the atmosphere. Observation Minus Reanalysis (OMR) had been confirmed the robustness method for detecting non-climatic changes at the station level associated with LULC changes. Beijing is one of the world's mega-cities which has experienced rapid urbanization over the past 30-40 years. The land use has changed considerably, with large of cropland converted to urban area. Meanwhile, the regional temperature showed increase trend. In this study we will apply the OMR method to quantitatively investigate whether there were some relationship between the LULC change and climate change in Beijing. We first investigated the LULC changes around 19 meteorological stations in Beijing based on LULC in 1990, 2000 and 2010. And we classified the stations by the dominant LULC type in each 3-km radius buffer zone centered at the stations. We applied the observed meteorological temperature and National Centers for Environmental Prediction (NCEP) reanalysis temperature in 1979-2010 to examine the difference of OMR trend for each representative station predominated by forestland, cropland, and urban land. Additionally, we analyzed the impacts of the primary LULC change in Beijing from cropland to urban land to determine whether changes in temperature occurred. The OMR temperature trends indicated that forest (-0.085°/10a) showed stronger inhibitory effects on temperature increase, which may be attributed to the continuous increasing of vegetation coverage in forest region since the implementation of many ecological projects for years. Higher levels of vegetation coverage corresponded to stronger transpiration, and the additional radiation energy will be partitioned into latent heat, and the sensible heat will be low. Thus, as the vegetation coverage increased, the OMR temperature trend decreased. For cropland, the annual and seasonal OMR trends are all negative, and in winter (-1.133°/10a) and spring (-0.299°/10a) the inhibiting impacts on climate warming were the most obvious. Large irrigation in spring and increase of snow in winter led to the temperature decreasing. For the urban area, the OMR temperature trend was 0.438°/10a, which showed strong warming effects. However, the LULC change from cropland to urban area due to the urbanization appeared to show the highest warming trend (0.548°/10a). The greatly change of underlying surface from soil and vegetation to impervious surface probably caused the temperature increase. Based on the impact on climate change and area proportion of individual LULC and LULC change, the combined climate effects had been estimated by area weighted method. The area weighted OMR trend was only 0.02°/10a in Beijing, which indicated that it seemed to be less impact of LULC and LULC change on regional temperature. But in fact the cooling effect of large area of forest and grassland with high vegetation coverage successfully inhibited the climate warming attributed to the rapid urbanization.