Geophysical Research Abstracts
Vol. 14, EGU2012-1460, 2012
EGU General Assembly 2012

Contributions of increased agricultural abandonment area to recent surface warming trend in Shikoku Island, Japan

R. Yoshida, M. Nishimori, T. Iizumi, and T. Osawa
National Institute for Agro-Environmental Sciences, Tsukuba, Japan

A remarkable increasing trend in abandoned cropland has already been observed in hilly and mountainous areas, Japan. Changes to abandoned areas from cropland (typically, paddy fields) could have impacts on surface air temperatures and their trends. We evaluated contributions of land surface change, specifically, the recently reported increases in abandoned cropland on daily maximum, mean, and minimum temperature with Shikoku Island, Japan where croplands have been significantly decreasing taken as an example. Land use change was expressed by the modifications of physical land surface parameters, i.e. surface albedo, evaporative efficiency, roughness length, heat capacity, and thermal conductivity. The sensitivity of the air temperatures to each land surface parameter was then derived from the numerical experiments using three-dimensional regional atmospheric model (JMA-NHM) and artificially modified land surface conditions. An accurate estimation of the contributions is expected as the JMA-NHM model allows us to consider three-dimensional land-atmosphere interactions that are impossible for one-dimensional land surface model alone.

We set the five land surface parameters and calculated a sensitivity of temperatures in regard to each land surface parameter change for the periods of 15th June to 15th August 1985, 1990, 1995, 2000, and 2005 when cropland area are presented in Japan. The experiment result showed that surface albedo and evaporative efficiency had significant sensitivity on the daily maximum and mean temperatures whereas heat capacity and thermal conductivity were impactful on the daily minimum temperature. Roughness length was less impactful for any temperatures. Parameter sensitivity showed geographical distribution, such as significant impact in inland area rather than coastal area for the response of daily mean temperature by surface albedo and evaporative efficiency changes. Lower sensitivity in coastal area was attributed to thermal advection from surrounding sea (e.g. land and sea breeze), mitigating air temperature changes caused by land surface parameter change. We derived geographical distributions of parameter sensitivity on air temperatures with these processes.

Temperature changes for 1985-2005 caused by cropland decreasing or abandoned cropland and building lots increasing were estimated based on parameter sensitivity to temperatures which were derived in previous calculation and cropland area data obtained from the Census for Agriculture, Forestry and Fisheries data set (Ministry of Agriculture, Forestry and Fisheries, Japan). Calculated temperature changes for 21-years using the sensitivity and the dataset were respectively 39.6, 46.0, and 27.5 % for the daily maximum, mean and minimum temperature to trends of 18-sites averaged observation stations in Shikoku Island, indicating significant impact of land surface change on air temperatures.

An evaluation method we applied in this study first calculated land surface parameter sensitivities on air temperatures with three-dimensional atmospheric model and secondly calculated linear combination of products of each sensitivity and cropland change ratio. Although first calculation needs high calculation cost because it uses three-dimensional atmospheric model, second one has little cost if once sensitivities were derived. This method would enable us to make air temperature change scenario caused by various land use change scenario without high numerical calculation costs.