# Impacts of land use changes during 1700-1850 on seasonal changes of land condition and water cycle over the East Asia

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1. Introduction

Vegetation plays an important role in land-atmosphere interaction, through energy and water balances at the earth's surface. Takata et al. (2009; TKT09) investigated impacts of historical land uses changes (HLUC) between 1700 and 1850 on Asian summer monsoon (ASM), by conducting AGCM experiments. As a result, HLUC significantly decreased ASM rainfall. This result was consistent with rainfall trend during this period derived from Himalayan ice core. However, they did not discuss impacts on seasonal changes of land condition and water cycle in the regions of extended HLUC. Therefore, this study focuses on impacts of HLUC between 1700 and 1850 on seasonal changes of land condition and water cycle in region extended HLUC, by analyzed experimental data derived from TKT09 and this study.

2. Experimental design

We conducted two numerical experiments, 1700VEG and 1850VEG, by using a MIROC3.2 coupled a MATSIRO. The distribution map of vegetation type in 1700 and 1850 was given as boundary condition in each experiment. Other boundary conditions, such as sea surface temperature, sea ice and CO2 were fixed at present-day climatology. Each experiment was conducted for 50 years, and we used the latter 40-year mean for analysis to examine changes induced by HLUC.

3. Results

We examined seasonal changes of land condition and water cycle over the Indian Subcontinent. We found decreased precipitation not only from July to August as shown by TKT09, but also in May and October. Wind speed at 10m became stronger throughout the year. Total evapotranspiration, transpiration and interception evaporation decreased throughout the year. The decreasing amount of total evapotraspiration from March to May (MAM) was greater than that in other seasons. Evaporation from the ground decreased in MAM and increased in other seasons. Soil moisture decreased throughout the year. Its amount was greater in dry season than in rainy season. In particular, it decreased notably in MAM. Sensible heat flux increased in MAM and decreased in other months. In particular, its increase was at the maximum from April to May. As a result, Bowen ratio was increased over the Indian Subcontinent in MAM.

As for seasonal changes of land condition and water cycle over South China, TKT09 concluded that rainfall amount over South China from June to August decreased after HLUC due to the roughness decrease. We found that the decrease in rainfall in August was smaller than that in June and July. We also found rainfall amount from March to May and in October decreased. Wind speed at 10m increased throughout the year, similarly that occurred in the Indian Subcontinent. Total evapotranspiration, interception evaporation and transpiration decreased throughout the year, which was also similar to the results in Indian Subcontinent. Evaporation from the ground, on the other hand, increased throughout the year, in contrast to the marked decrease in MAM over the Indian Subcontinent. Total evapotranspiration decreased by 0.5 mm day-1 throughout the year. Soil moisture also decreased throughout the year, but the decrease in spring over South China was not so pronounced at that over the Indian Subcontinent.Sensible heat flux increased from March to September after HLUC, similarly to that over the Indian Subcontinent. On the other hand, the marked decrease in soil moisture in spring did not appear over South China, as that over the Indian subcontinent.

4. Conclusion

We investigated the impacts of HLUC during 1700-1850 on seasonal changes of land condition and water cycle in the regions of extended HLUC. As a result, soil moisture markedly decreased and Bowen ratio increased in spring only over the Indian subcontinent, not over South China.