EGU24-5039, updated on 11 Oct 2024
https://doi.org/10.5194/egusphere-egu24-5039
EGU General Assembly 2024

Importance of biophysical forcing of global land cover to local precipitation and water vapor budget on the Loess Plateau of China

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Land use and cover change (LULCC) is an important climatic forcing. However, it is challenging to quantify the responses of local precipitation to LULCC forcing due to the complex interaction between the land surface and atmosphere. The ecologically fragile Loess Plateau (LP) of China has experienced evident changes in precipitation patterns, but the underlying mechanism remains unclear. The biophysical effects of LULCC on precipitation and the water vapor balance in the LP region were quantified based on the LULCC forcing experiments from the sixth phase of the Coupled Model Intercomparison Project (CMIP6). We found that the selected 11 Earth system models (ESMs) reproduced the general spatial pattern of annual precipitation on the LP region, with slight overestimation in the southern LP. The multimodel ensemble (MME) average showed that global LULCC forcing exerted a negative effect on long-term mean precipitation in this region during the period of 1850-2014. In particular, it decreased evidently during the period from 1850 to 1960, with a reduction of approximately 14.1 mm. However, a positive effect was detected for the period of 1961-2014, with an increase of 6.4 mm in annual precipitation. This is largely related to the intensified water vapor transport in the southern boundary and westerly belt of the LP region resulting from global LULCC forcing. Furthermore, water vapor balance analysis showed that global LULCC forcing resulted in a divergence in water vapor transport within the LP region, leading to a net water vapor output to the surrounding regions. These findings highlight the importance of considering global LULCC, in addition to regional LULCC, in studying regional climate change and associated impacts on the water cycle.