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Impact of vegetation changes on evapotranspiration in northern China

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Abstract: Terrestrial evapotranspiration (ET) is a crucial factor in the energy, hydrological, and carbon cycle. Several studies have investigated ET variations and trend, but only a few have focused on the impact of vegetation changes (such as vegetation expansion/decreasing and plant function type (PFT) change) on ET (Hoek van Dijke et al., 2022; Zheng et al., 2022).

Northern China has undergone significant vegetation changes due to the implementation of a large-scale ecological restoration project in 1999. This project has led to an increase in forest coverage and an improvement in the ecological environment. Satellite-based observations have revealed a significant increase in vegetation cover in northern China (Chen et al., 2019). Vegetation plays a crucial role in the water cycling between the soil and the atmosphere, and any change in vegetation directly impacts the regional evapotranspiration regime and hydrological process.

This study utilized a water-carbon coupled biophysical model, Penman-Monteith-Luening Version 2 (PML-V2), to quantify the impact of changes in vegetation on evapotranspiration across northern China from 2001 to 2018. Using the PML-V2 model, we conducted modeling experiments by applying the 'one-factor-at-a-time approach' to isolate the impact of vegetation (including leaf area index, PFT, albedo, emissivity), CO_2 and climate changes on ET. Our results indicate that the PML-V2 model can successfully isolate the impact of vegetation changes on ET in northern China. This is indicated by the fact that the ET trend modeled by changes in vegetation factors and climate is consistent with that from the PML-V2 model itself, with a bias of less than 10% in most parts of the region. We found that the impact of vegetation changes on ET increase is larger than the impact of climate change on ET increase in this region, particularly in the Loess Plateau. Among the various vegetation change factors, LAI contributed the most to the increase in ET, followed by changes in PFT and albedo. We also used various land cover and land use datasets to test the robustness of the results at both seasonal and annual scales. This study provides knowledge and valuable datasets to inform policymakers in the development of regional ecological environments and the management of water resources.

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