Changes in Global Warming Potential induced by vegetation restoration on the Loess Plateau, China

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Abstract

The vegetation cover of the Loess Plateau in China has been markedly restored through implementation of land management measures and ecological engineering. Previous studies of the effects of vegetation restoration on climate focused primarily on carbon sequestration and ignored biogeophysical effects. In this study, we used remote sensing data from 2001–2017 to quantify land cover change, vegetation restoration, and the corresponding differences in radiative forcing (RF). Furthermore, we derived the carbon dioxide (CO_2) equivalent for vegetation restoration from the 100-year global warming potential (GWP). Our results showed that cropland and forestland areas increased continuously from 2001–2017, with positive average rates of 13.76% and 33.24% per year, respectively. Vegetation greenness (expressed as the Normalized Difference Vegetation Index) also showed an increasing trend, indicating a gradual increase in vegetation activity. Conversely, surface albedo showed a decreasing trend closely related to the vegetation greenness increase. During the whole study period, both RF and GWP showed an increasing trend, with average annual rates of 0.13 W/m^2/yr and 0.19 $kgCO_2/m^2$/yr, respectively. The global average RF was 1.58 W/m^2 and the global average GWP was 3.7 $kgCO_2/m^2$. Vegetation restoration on the Loess Plateau induced an overall decrease in surface albedo, thus an increase in surface energy, or warming effect, equivalent to an emission of 3.7 $kgCO_2/m^2$. We concluded that it is essential to consider the biogeophysical effect of vegetation restoration when quantifying the global effect of vegetation on climate.

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