CO_2 controls on land vegetation in the Northern Hemisphere during the last glacial

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It is a key to understand the controlling mechanism of the carbon cycle in the earth’s surface to better understand the whole climate system. Previous studies revealed strong coupling of the climate and carbon cycle. Interesting feature of the past CO_2 record is that CO_2 level has never drewdown below around 190 ppm in glacial periods, suggesting that there is limit to atmospheric CO_2 on the geologically short timescale of glacial cycles. This feature is evident in the glacial-interglacial cycles in the late Pleistocene, implying an operation of the strong negative feedback, which directly respond to CO_2 change in timescale of <1,000 years. Vegetation feedback (the change in the biomass in response to CO_2 change) has been proposed as the negative feedback. However, this hypothesis has not demonstrated yet due to a difficulty of direct comparison of a vegetation record derived from sediment with the ice core CO_2. In this study, we reconstruct vegetation change (broadleaf tree vs grass) over the past 85 kyrs based on high-resolution analyses of plant biomarker (n-alkane C_{29}/C_{31} ratio) and pollen in Okhotsk Sea sediment core (XP07-C9), which allow us direct comparison of sedimentary record with ice core. Surprisingly, comparison of the vegetation and CO_2 records revealed that millennial scale vegetation change tightly coupled with CO_2 change rather than Dansgaard-Oeschgar cycle, which significantly exerted on millennial scale climate changes in the Northern Hemisphere during the last glacial period. This correspondence suggests that land biomass change even in high latitude region of the Northern Hemisphere is primary controlled by CO_2 changes during the last glacial period and vegetation plays an important role in climate system as a negative feedback which contribute to prescribe the lower limit of CO_2.

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