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Greenhouse climate forces expansion of peatlands into inland areas

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As a significant terrestrial carbon reservoir, peatland has great potential to affect the global carbon cycle and global climate. However, our understanding of broad-scale mechanisms that control the long-term global peatland expansion and carbon accumulation rates is still limited. Here we present a new data synthesis of global coal deposit location, thickness changes, carbon concentration, and distribution area changes, along with new carbon pool estimates of global peatlands from Devonian through geological time. By identifying orbital cycles in coal seams, we show that the long-term rate of carbon accumulation (LORCA) in peatland calculated from published data is controlled by pO_2, pCO_2, temperature, precipitation, and total solar irradiance. We use this relationship and latitudinal temperature gradients to reconstruct the equations between LORCA with latitude on different geological time. The results suggest that there are three main sets of high carbon pool and high carbon accumulation rate of global peatlands in Late Paleozoic, Early-Middle Jurassic, and Late-Cretaceous to Early Cenozoic under low tectonic activity and high terrestrial plant diversity background. In addition, we measure the shortest distances between all coal locations and coastlines based on the new Scotese's paleo-Atlas for the past 400 million years, in order to exhibit the extent of peatland expansion into inland. The result shows the Early-Middle Jurassic period has the longest average distance, which is probably due to the high sea level that minimizes the development of peat swamps on coastal areas and facilitated the moisture to move into deeper inland under the Jurassic Greenhouse climate condition. This study highlights that combining comprehensive coal-related database with paleoclimate, tectonics, and evolution of land plants provides insights into the mechanisms of the long-term behavior of the peatland expansion and carbon reservoir through deep time.

Keywords: Greenhouse climate, Peatland expansion, Carbon pool, Cabon accumulation rates, Coal

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