

## **Increased seasonality drove the C4 plant expansion in central Asia since the Miocene-Pliocene boundary**

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Previous study suggests that the fine-grained terrigenous sediments in the southwest Japan Sea originated primarily from eolian dust in the central Asia. Here we use continuous and high-resolution black carbon contents and carbon isotope of Integrated Ocean Drilling Program (IODP) Site U1430 in the Japan Sea to reconstruct past changes in vegetation types (C3/C4) of its source region since the last 13 Ma. The stable carbon isotope of black carbon ( $\delta^{13}\text{C}_{\text{BC}}$ ) shows a major shift at ~5.3 Ma, suggesting an significant expansion of C4 plants in broad areas of central Asia. The general coherent shift of carbon isotope across the late Miocene-Pliocene boundary recorded in the Japan Sea, as well as the Tarim Basin, Loess Plateau and inner Mongolia, strongly suggesting a dominant influence of regional factor on the C4 plant evolution in Central Asia. The onset timing of C4 expansion in central Asia delays by about 3 million years than the well-studied records in South Asia (~8 Ma). We suggest that, the decreased winter westerlies water vapor, linked to topography uplift in Pamir Plateau and Tianshan mountain as well as westward retreat of Paratethys Ocean driven by global cooling, leads to the extremely dry desert environment prevailed in North China and increases the seasonality of central Asia, further resulting in the C4 plants largely expanded in broad central Asia.