Can East Asian monsoon enhancement induce global cooling?

August 3 2021

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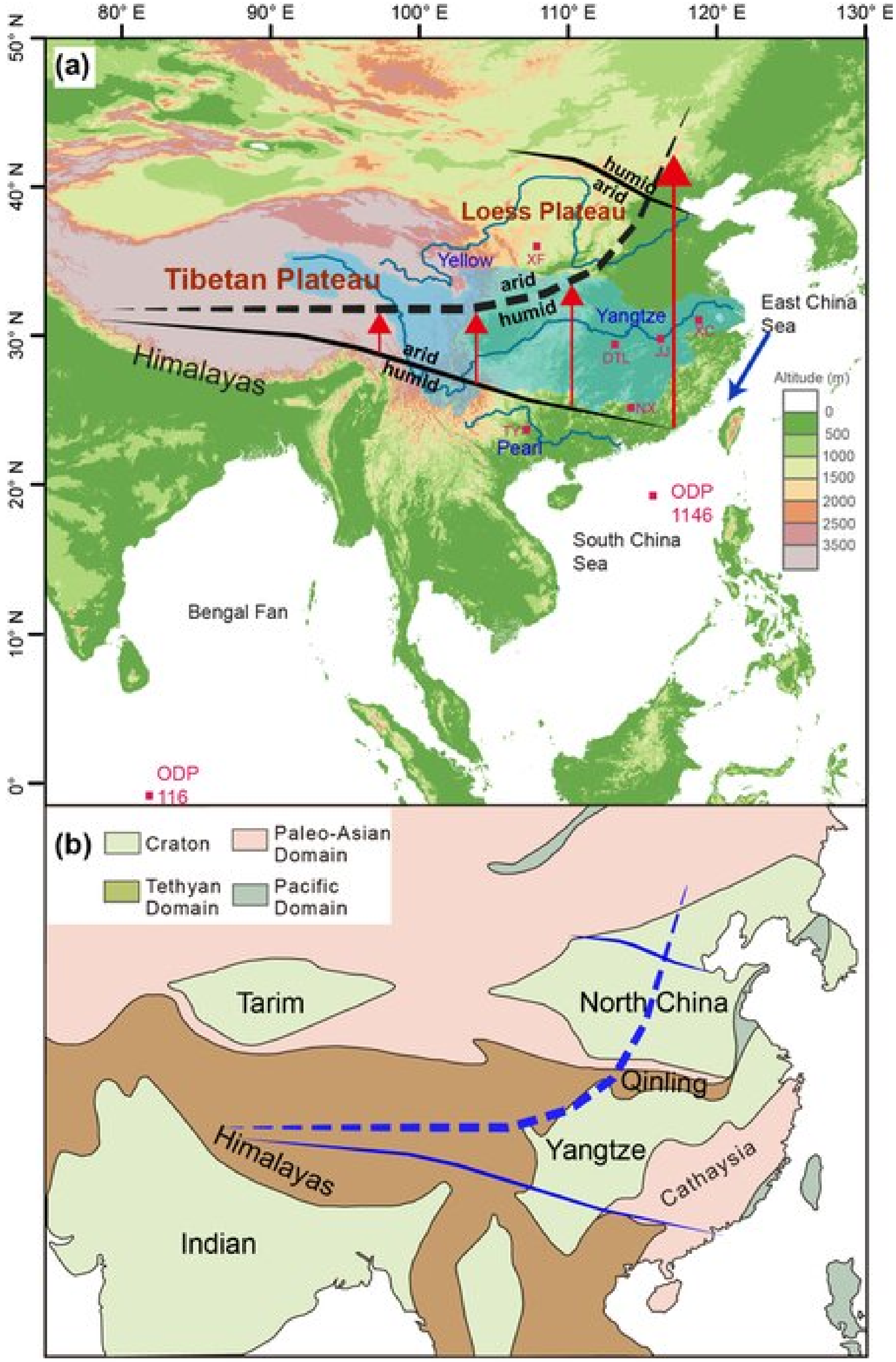
The study of the orogenic effects of the Tibetan Plateau uplift on global climate during the Cenozoic has focused almost exclusively on the India-Asia collision zone, the Himalayas. The strong erosion in the Himalayas was assumed to be a primary driver of Cenozoic atmospheric

CO_2 decline and global cooling predominantly through accelerating silicate chemical weathering in the India-Asia collision zone or through effective burial of organic carbon in the nearby Bengal Fan in South Asia.

However, the size of the India-Asia collision and the associated closure of the Tethys Ocean had a prominent effect on the reorganization of the climatic patterns beyond the collision zone. In an article coauthored with Yibo Yang and Albert Galy at Institute of Tibetan Plateau Research, Chinese Academy of Sciences and Centre de Recherches Pétrographiques et Géochimiques, CNRS-Université de Lorraine, and other colleagues, these researchers stated that "the Oligocene-Miocene boundary Asian climatic reorganization linked to the northward migration of the East Asian monsoon into subtropical China is a potentially important but poorly constrained atmospheric CO_2consumption process."

These twelve scholars performed a first-order estimation of the difference in CO_2 consumption induced by silicate weathering and organic carbon burial in subtropical China related to the monsoon advance around the late Oligocene. They revealed in the study, which was published in the *Science China Earth Sciences*, that the northward advance of the East Asian monsoon on tectonically inactive subtropical China induced globally significant silicate weathering atmospheric CO_2 sink. That is, an increase in long-term CO_2consumption by silicate weathering varies from 0.06 to 0.87×10^{12} $mol{\cdot}yr^{-1}$ depending on erosion flux reconstructions, with an ~50% contribution of Mg-silicate weathering since the late Oligocene. The organic carbon burial flux is approximately 25% of the contemporary CO_2 consumption by silicate weathering.



Cenozoic humid/arid boundaries in China for the Palaeogene (bold line) and the Neogene to Quaternary (dashed line). Red arrows show the northward migration of the humid zone. Credit: Science China Press

The first-order calculation of CO_2 consumption highlighted the very significant role of the weathering of the Mg-rich Yangtze craton and surrounding terranes because the unusual Mg-rich nature of eroded crust not only enhances the tectonic forcing of climate but also can contribute to the rise in the Mg content of the ocean during the Neogene.

The study provided a novel perspective on the Cenozoic carbon cycle linked to the Mg-rich nature of the crust affected by such uplift-driven climatic change and illustrated how complex the perturbations of global climate and atmospheric CO_2 levels by orogenic uplift can be, and how important the nature of the crust is, not only that involved in the collision but also that around the collision. In past decades, the role of the heterogeneity of the crust and/or the lithosphere has been highlighted in other geosciences disciplines, and the distinction between mantle-derived and upper crustal rocks was already well integrated in the long-term climate science community. "But to our knowledge," write the researchers, "the key findings of this study (the importance of the composition of the crust, and the spatial extent of the perturbations of global climate and atmospheric CO_2 levels by orogenic uplift) suggests that the tectonics affects Cenozoic cooling via modulation of the geological carbon cycle in diverse ways, and such forcing might not be fully extrapolated to older global-scale orogeny."

More information: Yibo Yang et al, East Asian monsoon intensification promoted weathering of the magnesium-rich southern China upper crust and its global significance, *Science China Earth Sciences* (2021). DOI: 10.1007/s11430-020-9781-3

Provided by Science China Press

Citation: Can East Asian monsoon enhancement induce global cooling? (2021, August 3)