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Co-evolution of monsoonal precipitation in East Asia and the tropical Pacific ENSO system since 2.36 Ma

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Clay mineralogical analysis and scanning electron microscope (SEM) analysis were performed on deep-sea sediments cored on the Benham Rise (core MD06-3050) in order to reconstruct long-term evolution of East Asian Summer Monsoon (EASM) rainfall in the period since 2.36 Ma. Clay mineralogical variations are due to changes in the ratios of smectite, which derive from weathering of volcanic rocks in Luzon Island during intervals of intensive monsoon rainfall, and illite- and chlorite-rich dusts, which are transported from East Asia by winds associated with the East Asian Winter Monsoon (EAWM). Since Luzon is the main source of smectite to the Benham Rise, long-term consistent variations in the smectite/(illite + chlorite) ratio in core MD06-3050 as well as ODP site 1146 in the Northern South China Sea suggest that minor contributions of eolian dust played a role in the variability of this mineralogical ratio and indicate strengthening EASM precipitation in SE Asia during time intervals from 2360 to 1900 kyr, 1200 to 600 kyr, and after 200 kyr. The EASM rainfall record displays a 30 kyr periodicity suggesting the influence of El Niño–Southern Oscillation (ENSO). These intervals of rainfall intensification on Luzon Island are coeval with a reduction in precipitation over central China and an increase in zonal SST gradient in the equatorial Pacific Ocean, implying a reinforcement of La Niña-like conditions. In contrast, periods of reduced rainfall on Luzon Island are associated with higher precipitation in central China and a weakening zonal SST gradient in the equatorial Pacific Ocean, thereby suggesting the development of dominant El Niño-like conditions. Our study, therefore, highlights for the first time a long-term temporal and spatial co-evolution of monsoonal precipitation in East Asia and of the tropical Pacific ENSO system over the past 2.36 Ma.