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The forced response of Asian Summer Monsoon precipitation during the past 1500 years

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Asian summer monsoon (ASM) is one of the critical elements of the global climate system, and strongly affects food production and security of most people over Asia. However, the characteristics and the forcing drivers of the ASM system at decadal to centennial time scales remain unclear. To address these issues, we report four 1500-yr long climate model simulations based on the Community Earth System Model (CESM), including full-forced run (ALLR), control run (CTRL), natural run (NAT), and anthropogenic run (ANTH). After evaluating the performances of the CESM in simulating ASM precipitation, a 10-100 bandpass filter is applied to obtain the decadal-centennial signals in ASM precipitation. The main conclusions are (1) the variation of ASM intensity shows significant decadal to centennial periodicities in the ALLR, such as ~15, ~25, ~40, and ~70 years. (2) the major spatial-temporal ASM precipitation distributions in the ALLR show an external forced mode and climate internal variability mode, respectively. (3) The leading forced mode of ASM precipitation is mainly affected by natural forcing over the past 1500 years and characterizes a meridional spatial 'tripole' mode. In the NAT (solar irradiation and volcanic eruptions), the substantial warming (cooling) over the western tropical Pacific enhances (or reduces) the SST gradient change in the tropical Pacific, and modifying the ASM rainfall distribution. Our findings contribute to better understanding of the ASM in the past, and provide implications for future projections of the ASM under global warming.