EGU21-13993
https://doi.org/10.5194/egusphere-egu21-13993
EGU General Assembly 2021

Volcanic-induced global monsoon drying modulated by diverse El Niño responses

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This study identifies a crucial cause of the large uncertainty in global precipitation response after volcanic eruptions. We find an important contribution of diverse El Niño responses to the inter-simulation spread in the global monsoon drying responses to tropical eruptions. Most Coupled Model Intercomparison Project Phase 5 (CMIP5) models simulate El Niño–like equatorial eastern Pacific warming at the year after eruptions but with different amplitudes, which drive a large spread of summer monsoon weakening and corresponding precipitation reduction. Two factors are further identified for the diverse El Niño responses among CMIP5 model simulations. First, difference in imposed volcanic forcings induces systematic differences in the Maritime Continent precipitation drying and subsequent westerly winds over equatorial western Pacific, accounting for a large portion (29%) of inter-simulation spread in El Niño intensities following eruptions. In addition, the internally generated warm water volume over the equatorial western Pacific in the pre-eruption month also contributes to the diverse El Niño development, explaining about 14% of the total inter-simulation variance through the recharge oscillator mechanism. Our findings based on CMIP5 multi-model simulations confirm that reliable estimates of the volcanic forcing magnitude as well as the pre-eruption oceanic condition are required to obtain more reliable simulations or predictions of the hydrological responses to tropical eruptions.