기후 분과 [P-003]

Hysteresis in the Characteristics of Moist Heatwaves over the Indian Subcontinent in a Carbon Dioxide Removal Simulation

Yuna Jin, Daehyun Kim, and Seungmok Paik

School of Earth and Environmental Sciences, Seoul National University

As global warming poses severe threats to humanity, climate change mitigation strategies and climate engineering projects have been developed to reduce atmospheric CO_2 concentration. However, the climatic consequences of such efforts remain uncertain. Carbon Dioxide Removal (CDR) experiments offer a framework to investigate the potential outcomes of reducing CO_2 concentration and to examine the trajectory of future climate states.

Moist heatwaves refer to unusually high temperatures accompanied by high humidity, and they are directly associated with human physiological dangers. The Indian subcontinent experiences a high frequency of such events, particularly during the summer monsoon season, due to its climatologically high humidity and temperature. To examine the potential hysteresis of moist heatwaves over the Indian subcontinent, we compare two periods with the same atmospheric CO_2 concentrations: CO_2 ramp-up and ramp-down period. The occurrence probability of moist heatwaves exhibits large hysteresis throughout the summer monsoon season with the strongest signal in August; moist heatwave occurrence probability increases in the ramp-down period compared to the ramp-up period. There is hysteresis in near-surface temperature and specific humidity: in the ramp-down period, near-surface temperature increases while specific humidity decreases. In summary, the increase in near-surface temperature drives the moist heatwave occurrence probability hysteresis (i.e., an increase in probability), while the decrease in near-surface specific humidity partly offsets this effect. The contrast between the hysteresis of temperature and humidity suggests a possible shift in the moist heatwave regime from humidity-driven moist heatwave to temperature-driven moist heatwave. Moreover, the intensity of moist heatwaves increases during the ramp-down period due to the increase in near-surface temperature.

Keywords: Moist Heatwave, Carbon Dioxide Removal (CDR), Indian subcontinent