Unveiling the influences of soil moisture on summer moist heat stress extremes: a global assessment using CMIP6 data

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Introduction

Soil moisture is a key variable in land-atmosphere interactions, as it affects the partitioning of near-surface energy fluxes and thereby temperature and humidity of the lower atmosphere. Both ambient temperature and humidity play a crucial role in the removal of heat from the human body through direct heat transfer and sweat evaporation, therefore these two factors are commonly used in measuring moist heat stress. As moist heat stress describes the combined effects of temperature and humidity on human health and well-being, understanding the intricate relationship between soil moisture and moist heat stress is crucial for accurately assessing and mitigating moist heat extremes. Whereas the impact of soil moisture on temperature is well understood, previous research has found non-trivial and complex relations between soil moisture and moist heat stress due to humidity feedbacks.

Methodology

Variable

Discomfort Index (DI): relative humidity and temperature

Dataset

CMIP6 LS3MIP pdLC

(a) remove impacts from soil moisture trend at multidecadal time scales

(b) remove short-term land-atmosphere interactions at interannual and sub seasonal time scales

Comparison between pdLC and control experiment

Soil moisture effects

Definitions

>= 27 hot days
most of the population in discomfort

>= 29 extremely hot days
severe stress

This presentation participates in OSPP

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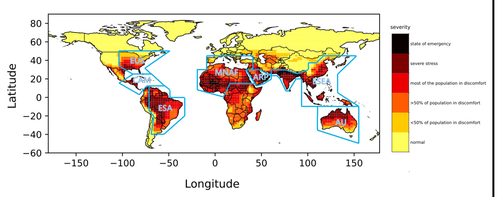
Outstanding Student & PhD candidate Presentation contest

Results

Domains Definition and 2040-2070 Moist Heat Level



Conclusion First

1. Compared with global average, more and non-trivial contributions from soil moisture changes are found over most of the selected domains;
2. It is found that soil moisture effects are stronger in selected domains;
3. All the selected domains experience an increasing trend of moist heat and (extremely) hot days;
4. ARP, CAM, and ESEA are three domains where more (extremely) hot days happen than others;
5. Even though with different variability among the selected domains, L-A feedbacks tend to remain in a level and a continuity of whether positive or negative influences on moist heat and (extremely) hot days

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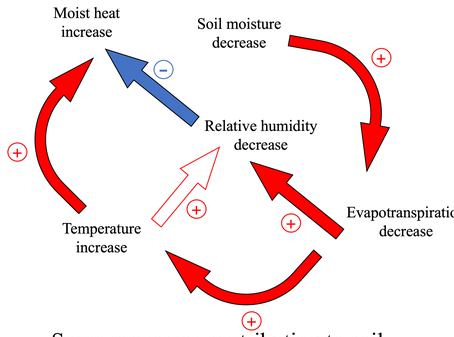

Some processes contributing to soil moisture-moist heat coupling

Revised from Seneviratne et al. 2010

Fig. 1: Contributions from L-A feedbacks on projected changes of moist heat and (extremely) hot days

Fig. 2: L-A feedbacks in two periods

Fig. 3: Temporal changes of moist heat, hot days, extremely hot days, and soil moisture effects on them respectively

Fig. 2

red color: soil moisture trend tends to amplify moist heat and increase (extremely) hot days; blue color: the opposite

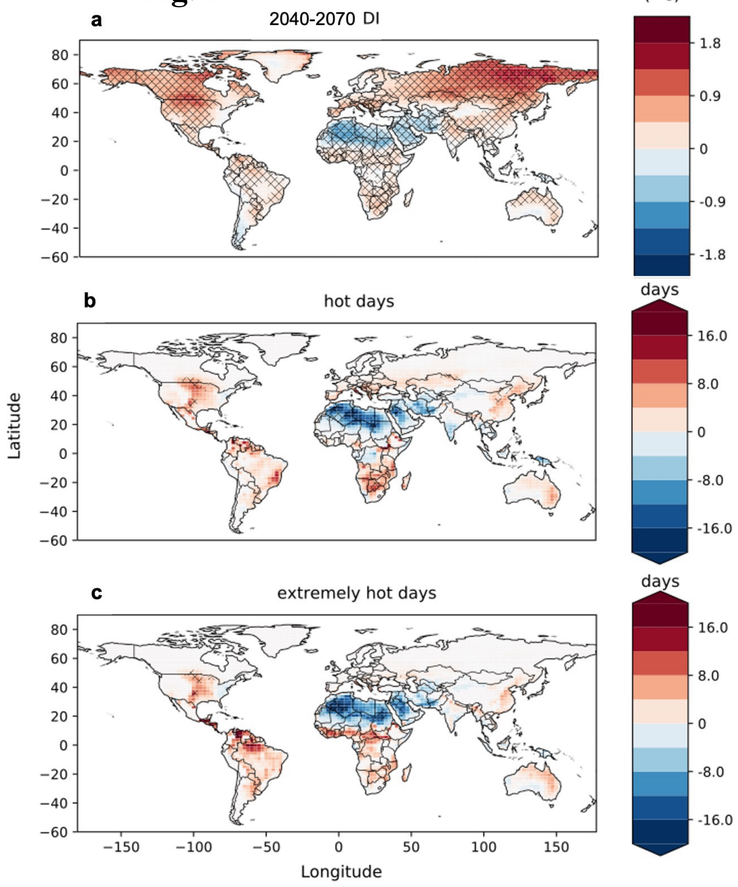

Fig. 3 (selection for global land, ARP, CAM, ESEA)