Emergent constraint unlikely to reduce spread in projected warming of heat extremes over land

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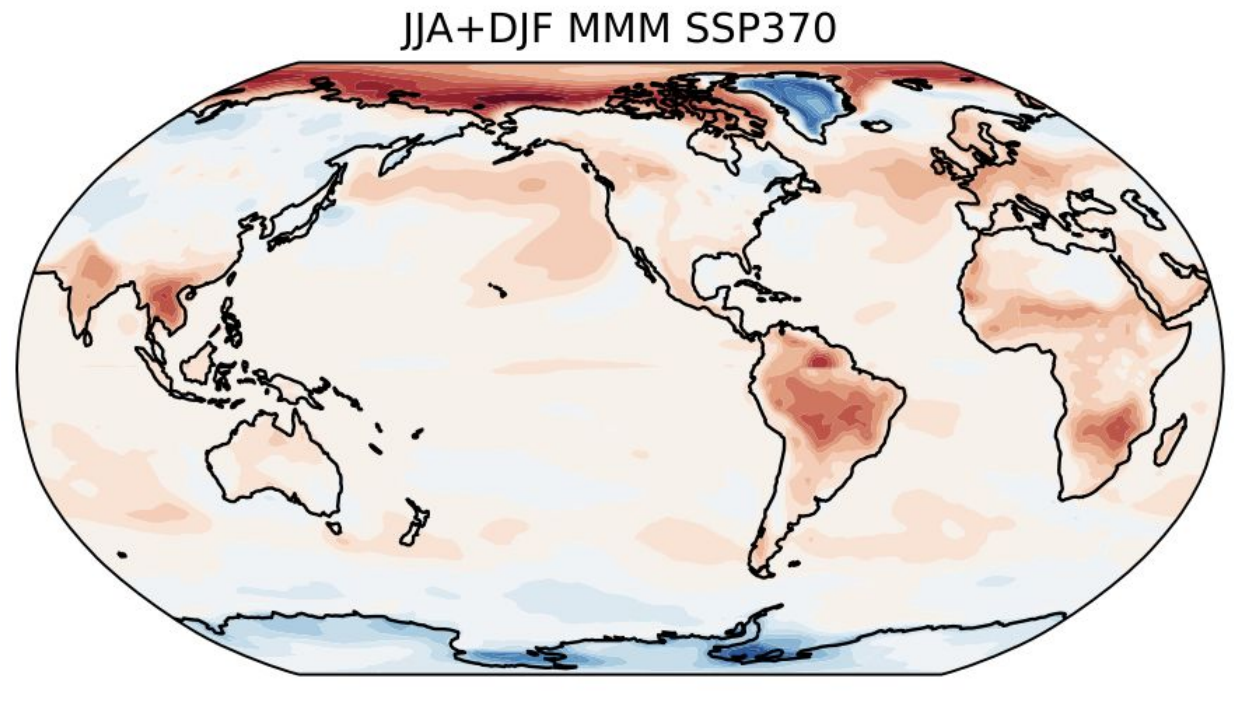
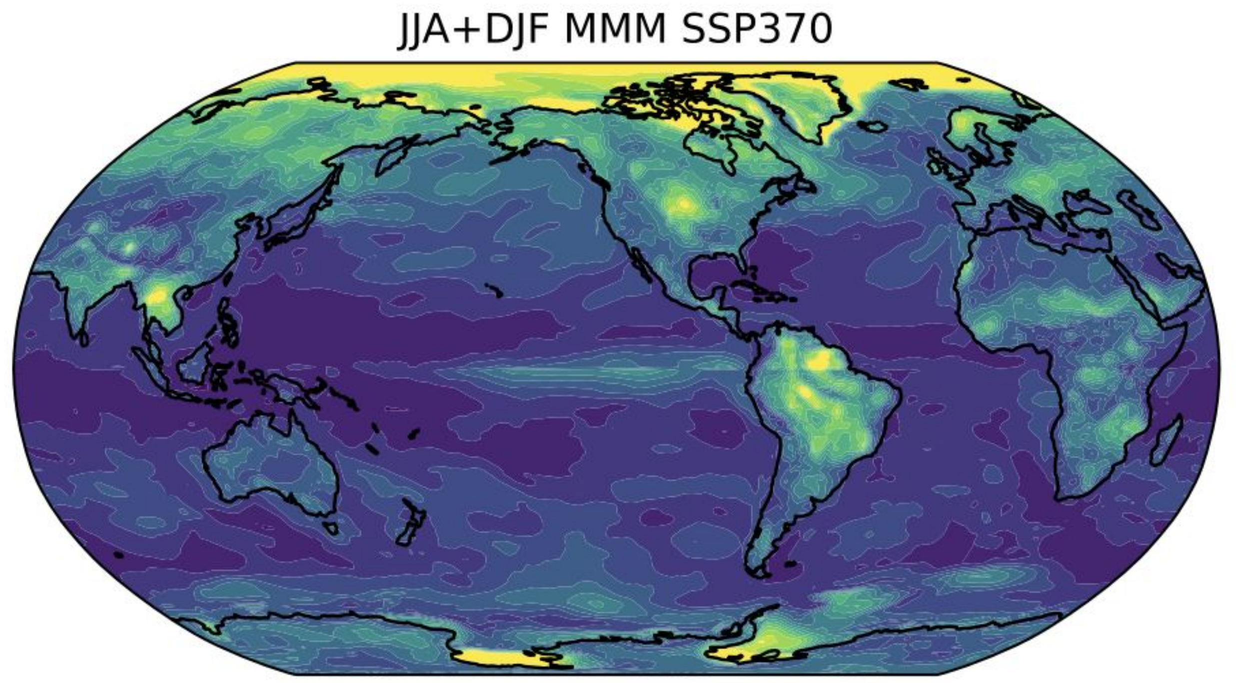
1. Climate models project hot days (>95th percentile) will warm more than average days in a 2 K warmer world.



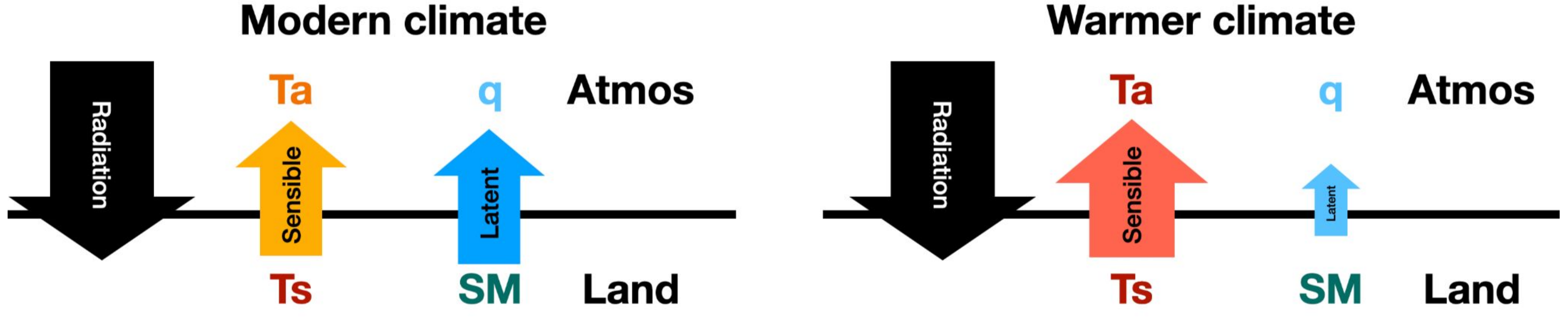
Summertime amplified hot-day warming (K)

2. However, intermodel spread of amplified hot-day warming is as large as the signal itself.

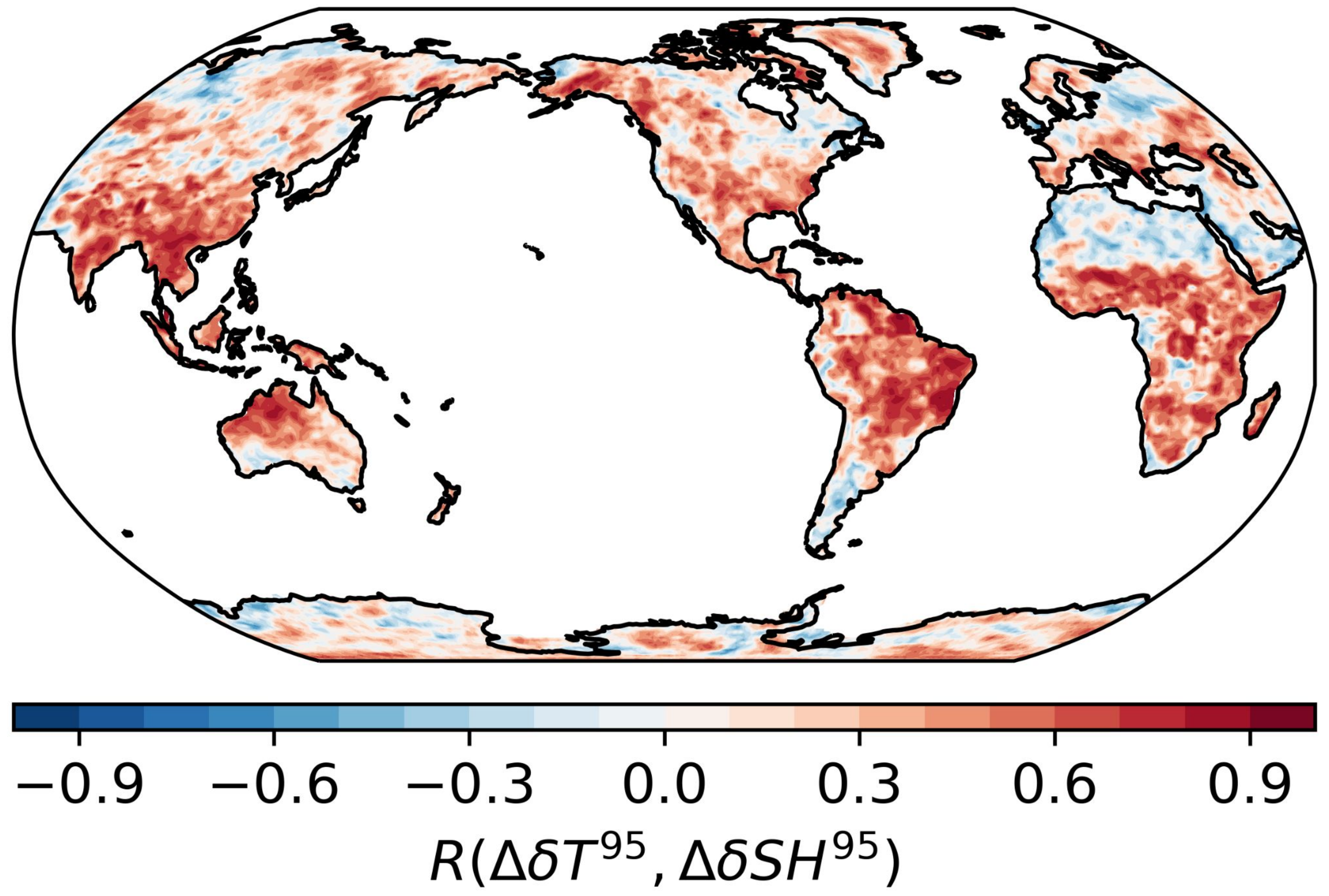


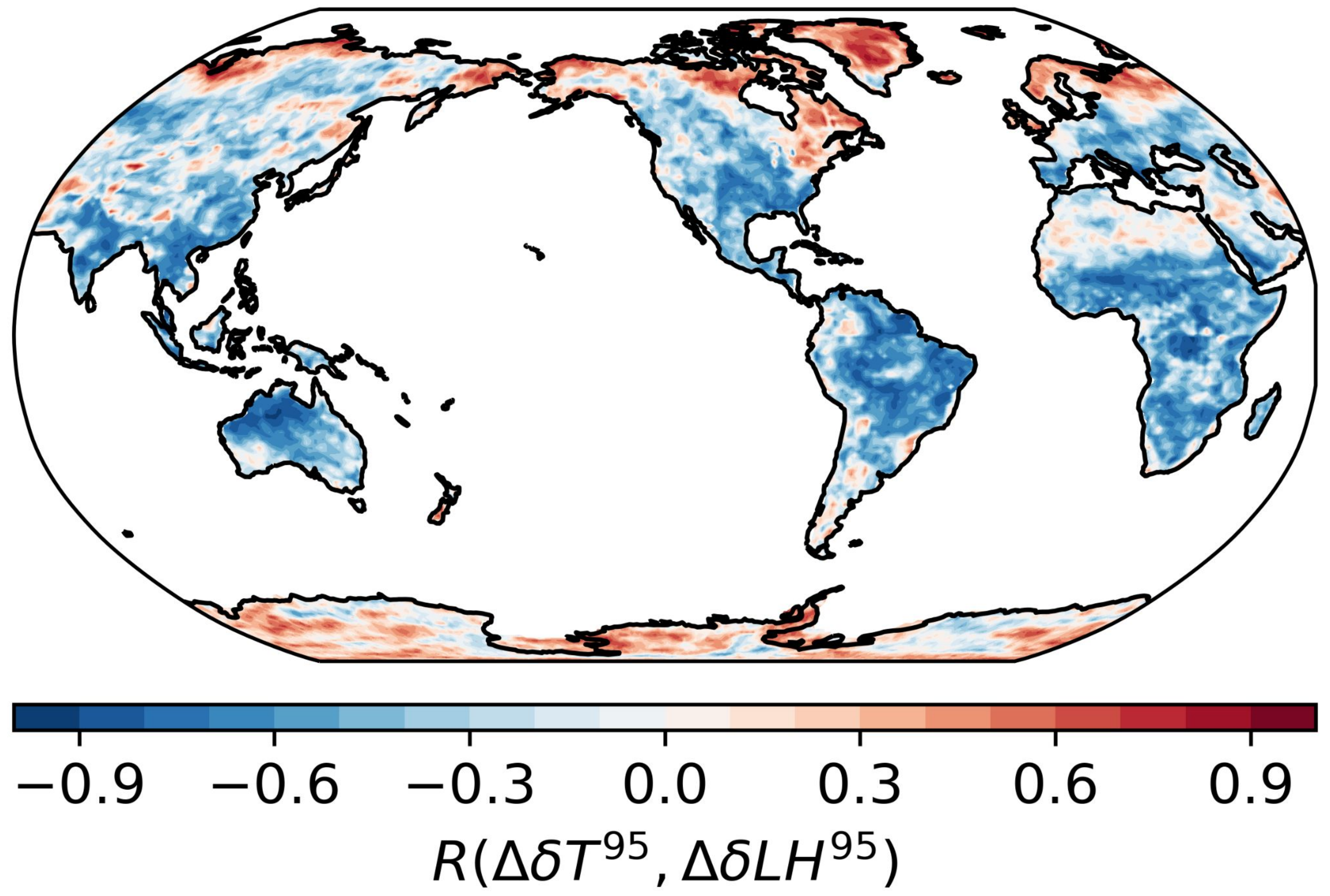
Intermodel standard deviation of summertime amplified hot-day warming (K)

3. Over land, surface energy balance is a useful framework for understanding surface warming. In a warmer world, increased volatility of precipitation (heavier burst of rain interspersed by longer dry spells) leads to drier soil as a larger fraction of precipitation is transported as runoff instead of infiltrating the soil column. This leads to a repartitioning of surface turbulent fluxes from latent to surface turbulent fluxes.



4. Consistent with this hypothesis, intermodel spread in amplified hot-day warming is positively correlated with spread in amplified hot-day sensible heat flux change and negatively correlated with spread in amplified hot-day latent heat flux.

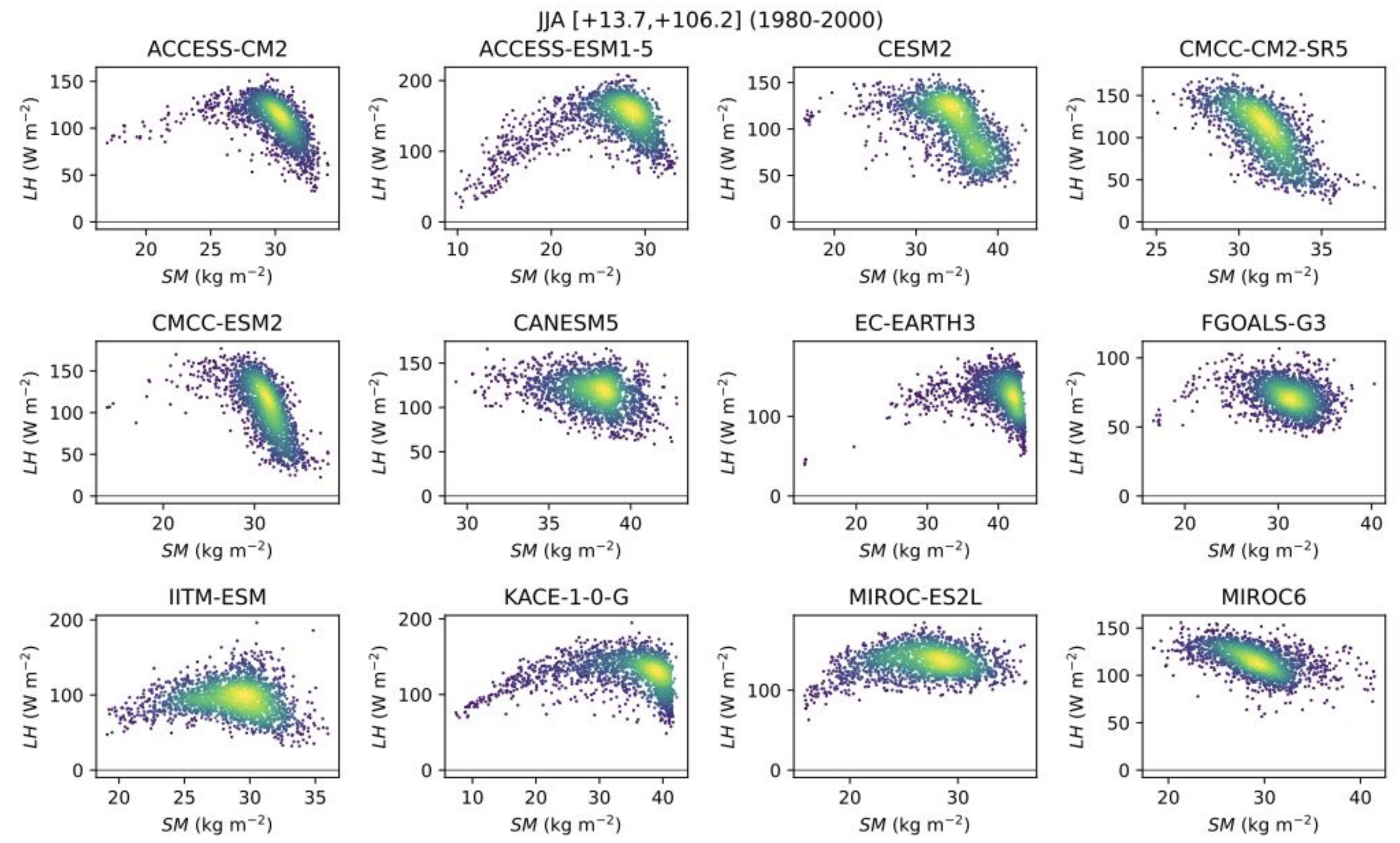




5. Soil moisture (SM) exerts a non-linear control on latent heat flux. In this framework, intermodel spread in the latent heat flux (LH) response can come from 4 contributions:

A. spread in the LH-SM response to warming
B. spread in the historical LH-SM relationship
C. spread in the soil moisture response to warming
D. spread in historical soil moisture

If either contribution B or D dominates, model spread in projections of hot-day warming may be reduced by an emergent constraint approach.



6. The fraction of intermodel variance explained by contributions B and D are negligible. Instead, the sources of intermodel variance are associated with differing responses of the LH-SM relationship and hot-day soil moisture. This suggests reducing the intermodel spread in amplified hot-day warming should focus on understanding intermodel spread in land-atmosphere feedbacks rather than hydroclimate biases in the current climate.