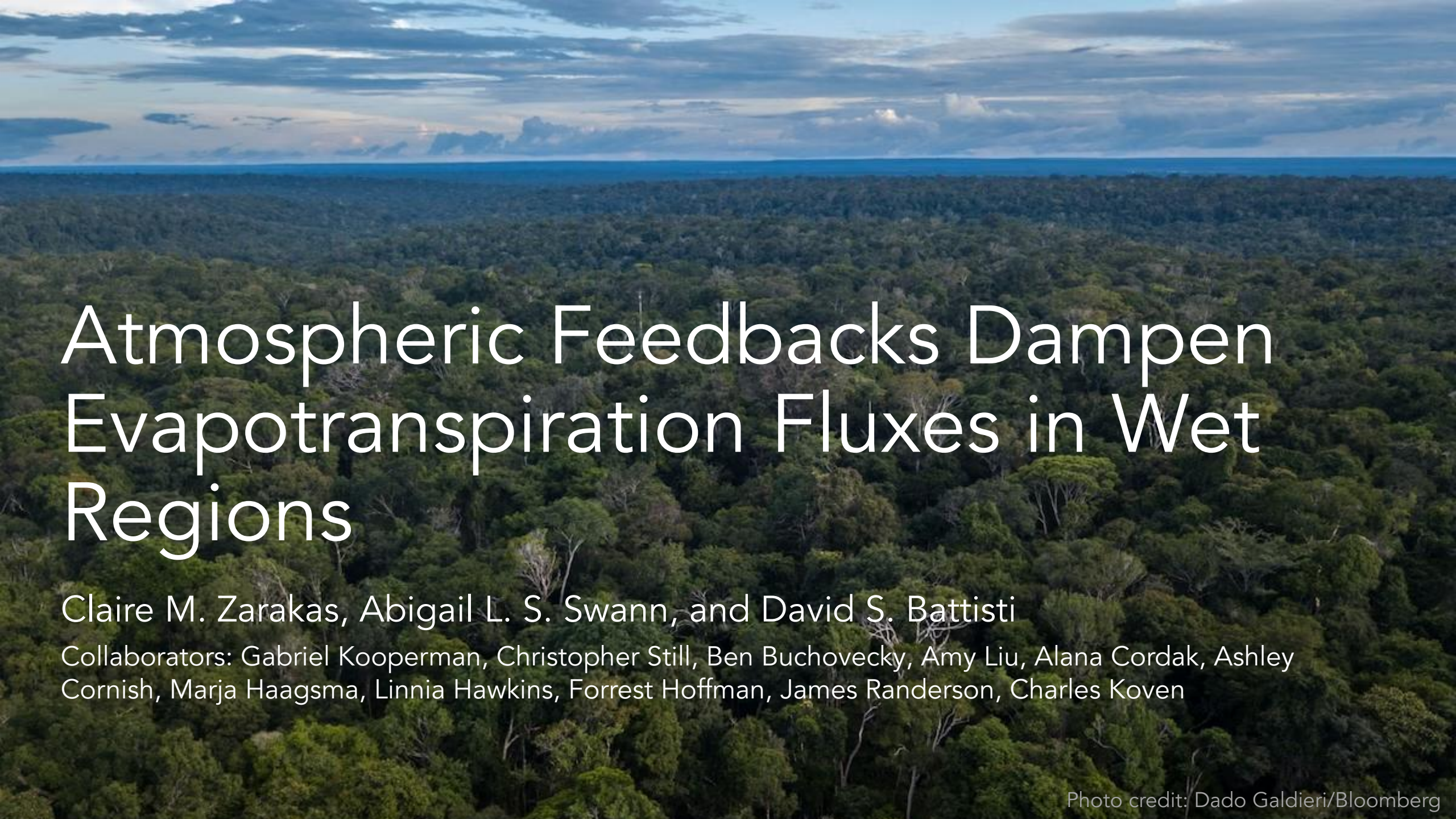


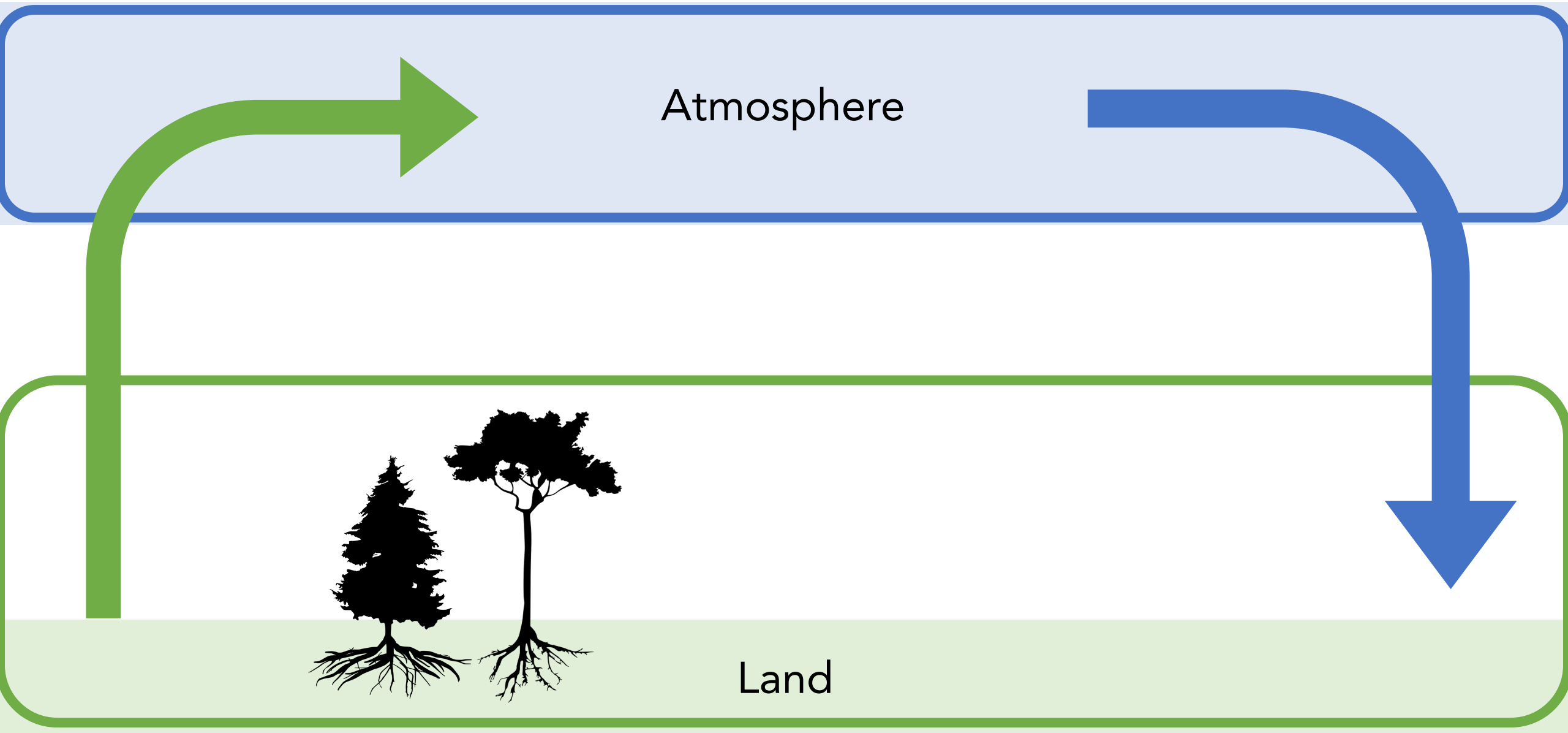
Atmospheric Feedbacks Dampen Evapotranspiration Fluxes in Wet Regions

Claire M. Zarakas, Abigail L. S. Swann, and David S. Battisti

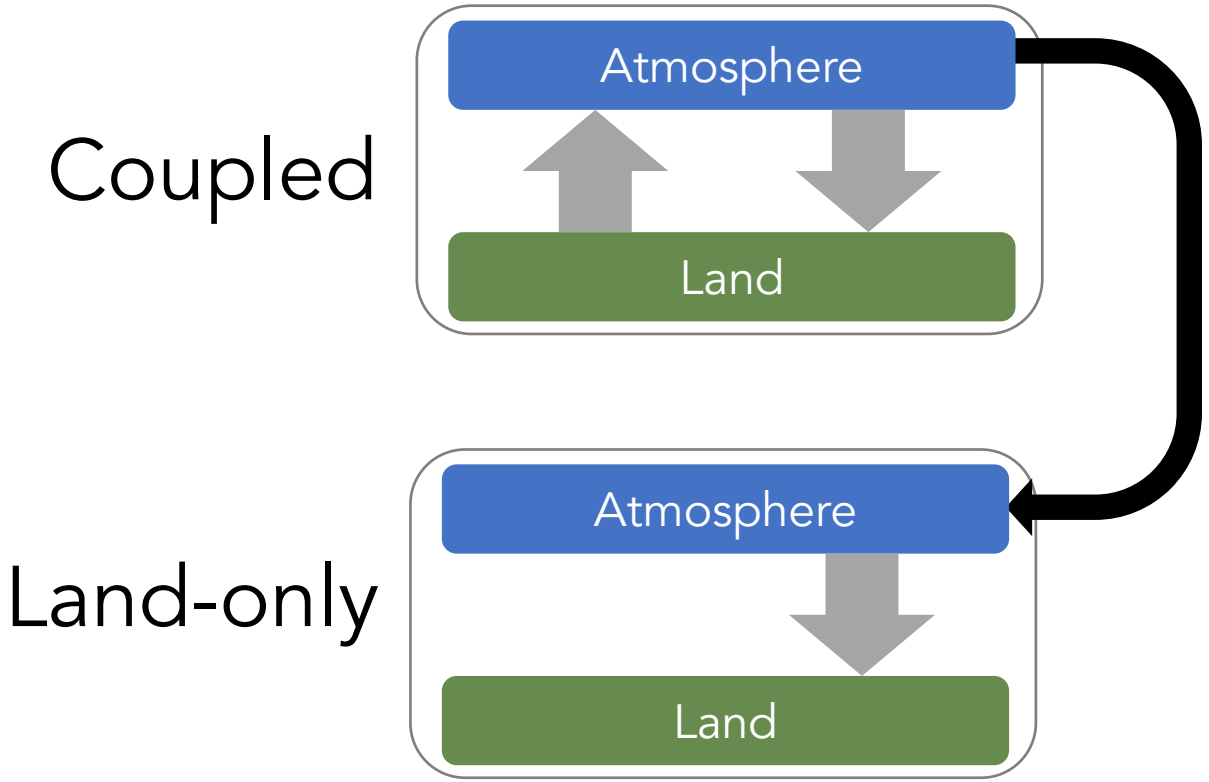
Collaborators: Gabriel Kooperman, Christopher Still, Ben Buchovecky, Amy Liu, Alana Cordak, Ashley Cornish, Marja Haagsma, Linnia Hawkins, Forrest Hoffman, James Randerson, Charles Koven

Photo credit: Dado Galdieri/Bloomberg

How do land-atmosphere feedbacks modulate changes in ET?

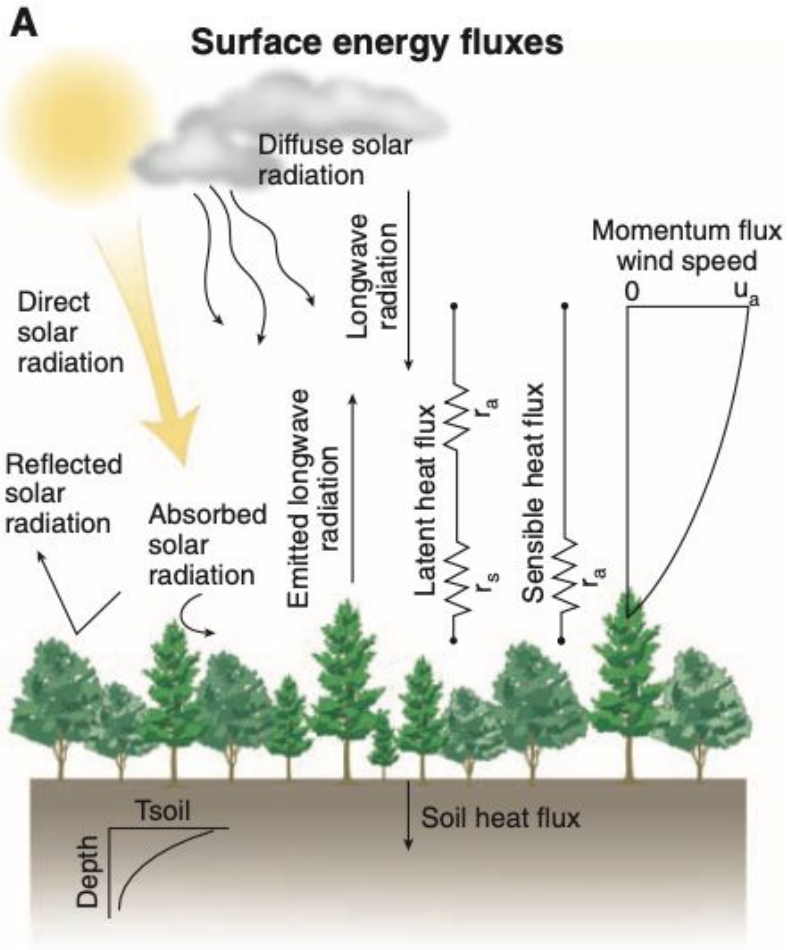


Isolated the impact of land-atmosphere feedbacks using paired perturbed parameter ensembles (PPEs)



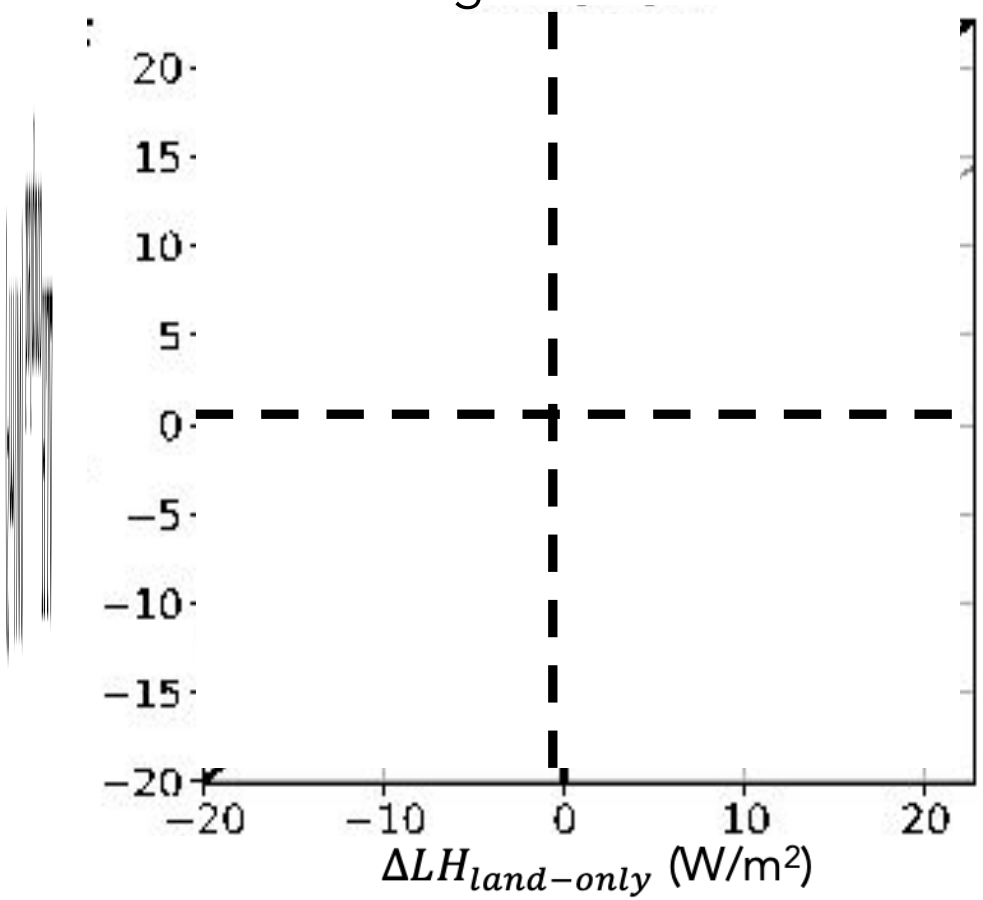
Ran one-at-a-time preindustrial simulations for 18 land parameters

- 18 land parameters relate to diverse terrestrial processes, e.g. soil hydrology, photosynthesis, and stomatal conductance
- Perturbed to observationally-informed minimum and maximum values
- CESM2: CAM6, CLM5, slab ocean
- Constant 1850 conditions (CO_2, CH_4, etc.)
- 140 year simulations

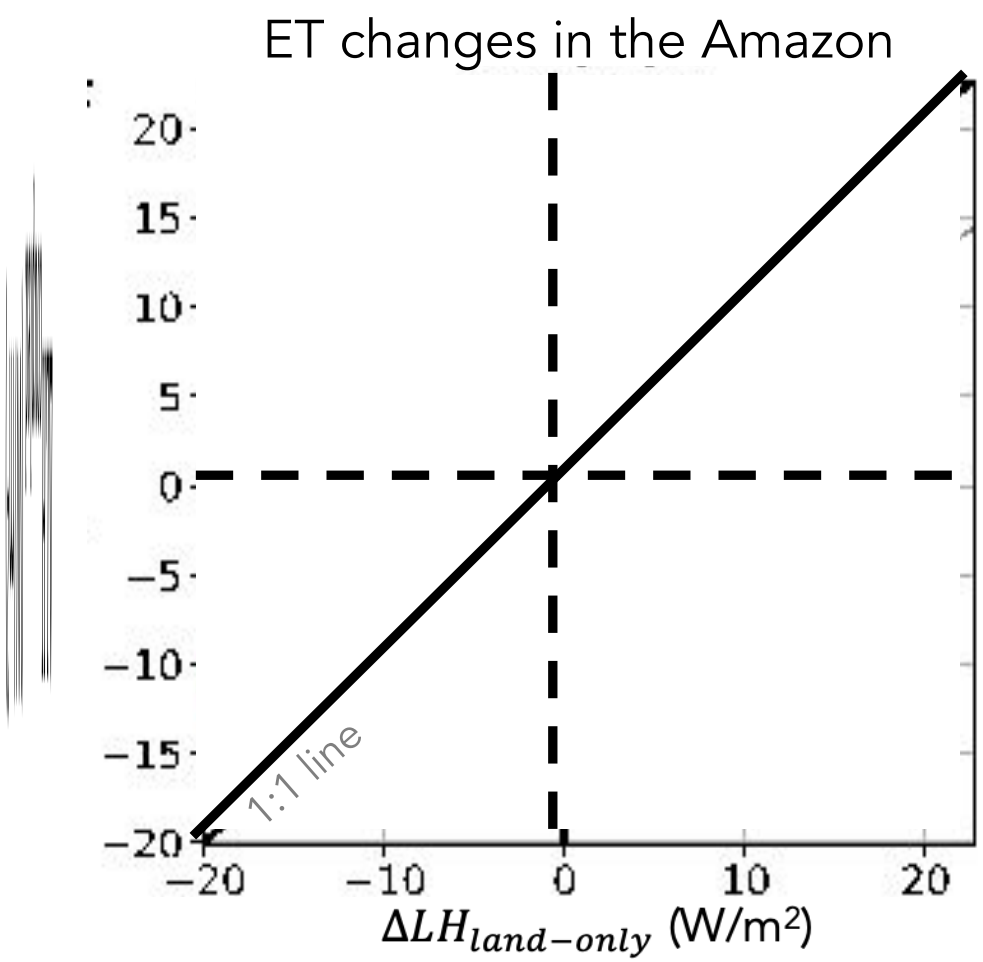


Pairwise comparison of land-only and coupled simulations

ET changes in the Amazon



Pairwise comparison of land-only and coupled simulations



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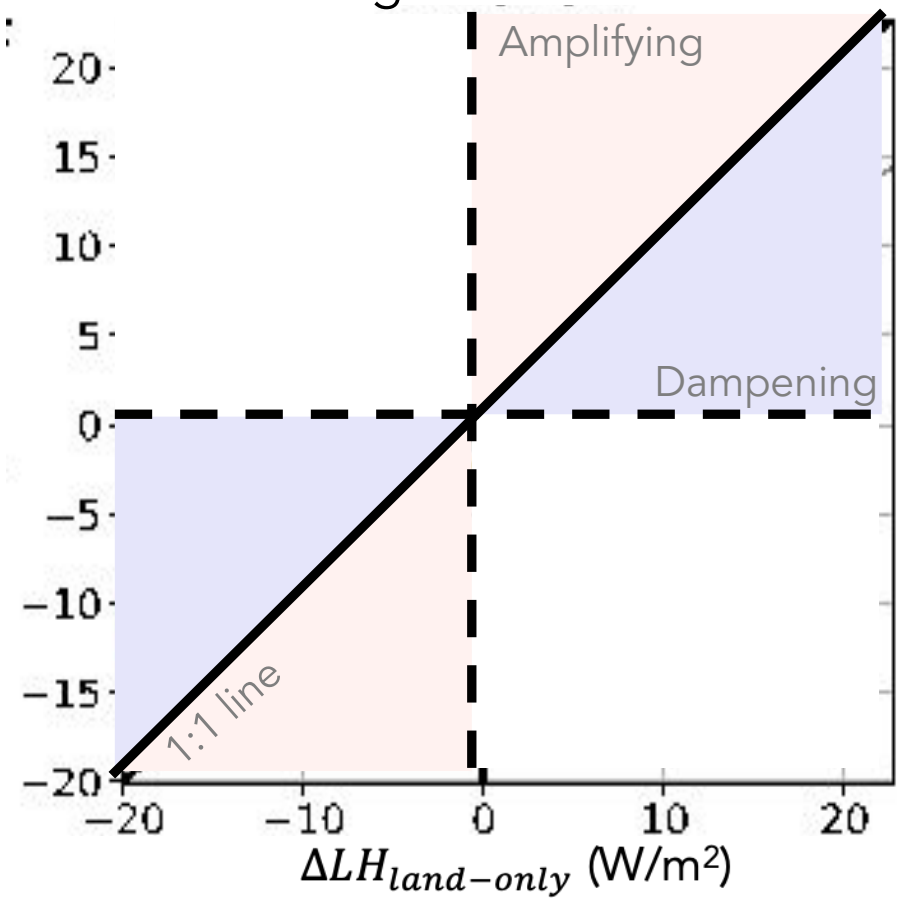
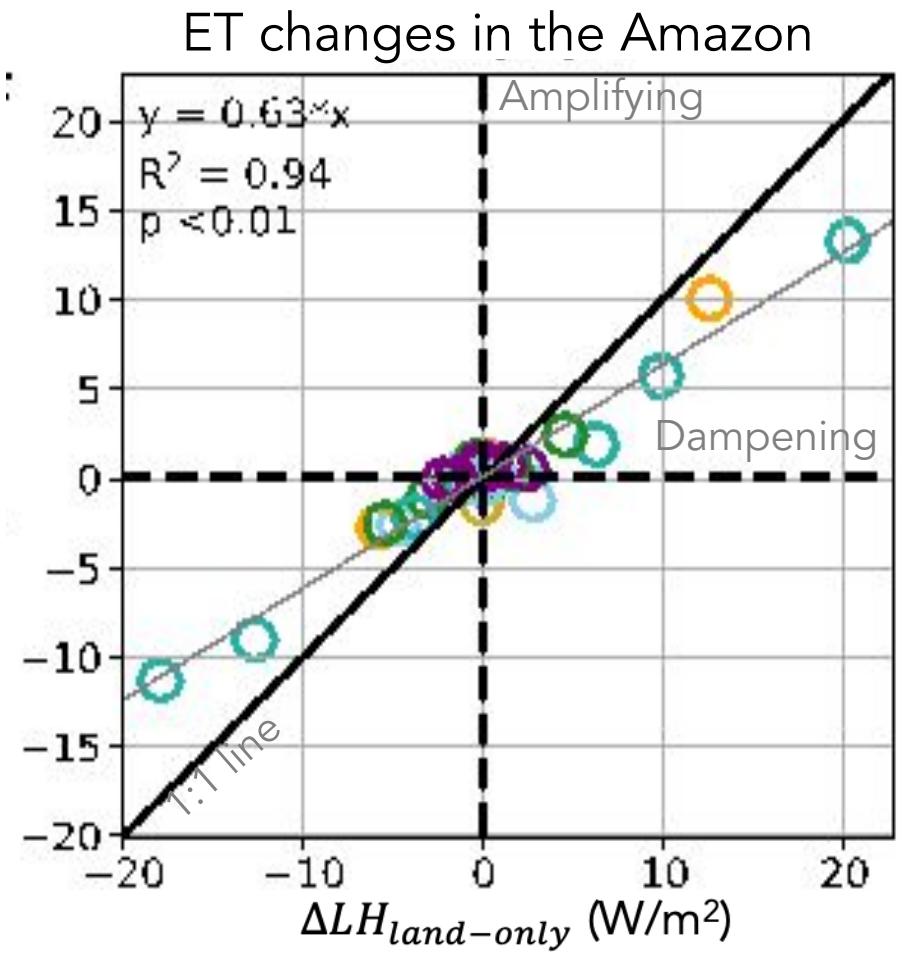
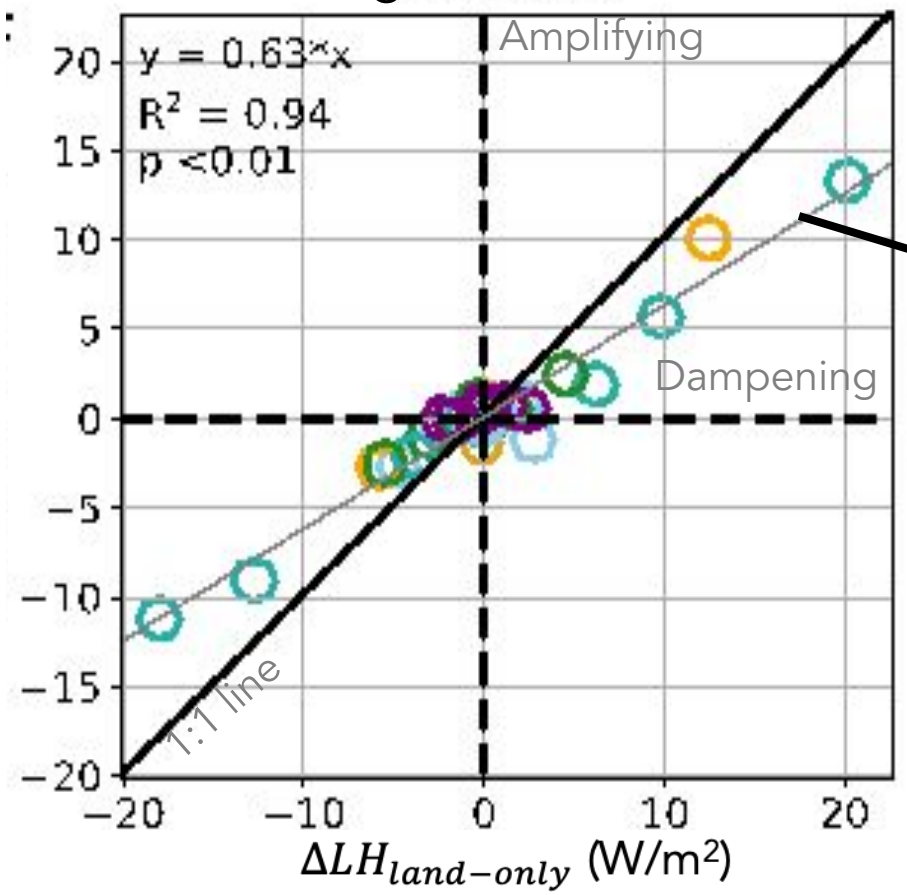


Land-atmosphere feedbacks dampen ET changes in the Amazon

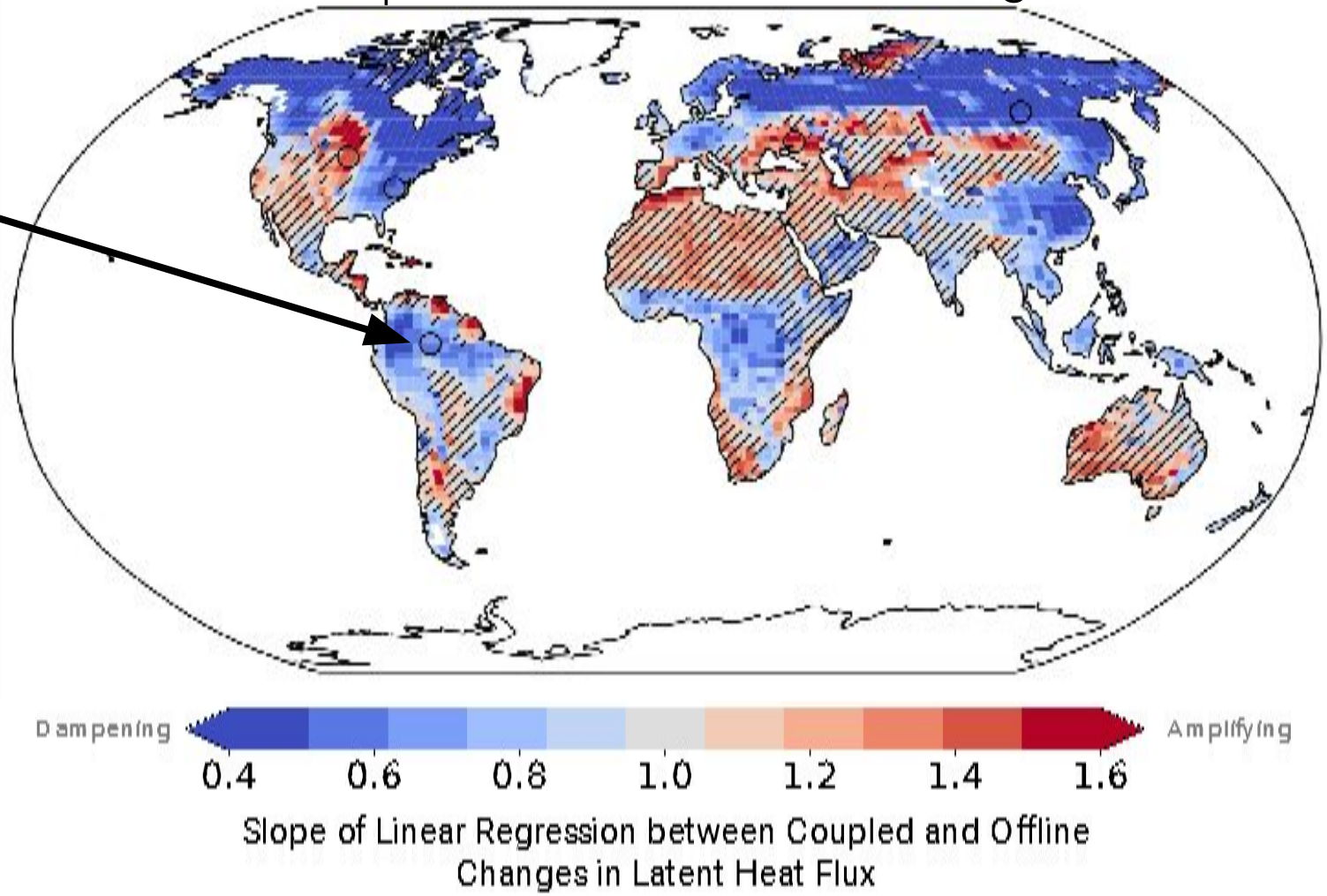


Atmospheric feedbacks' influence on ET varies spatially

ET changes in the Amazon

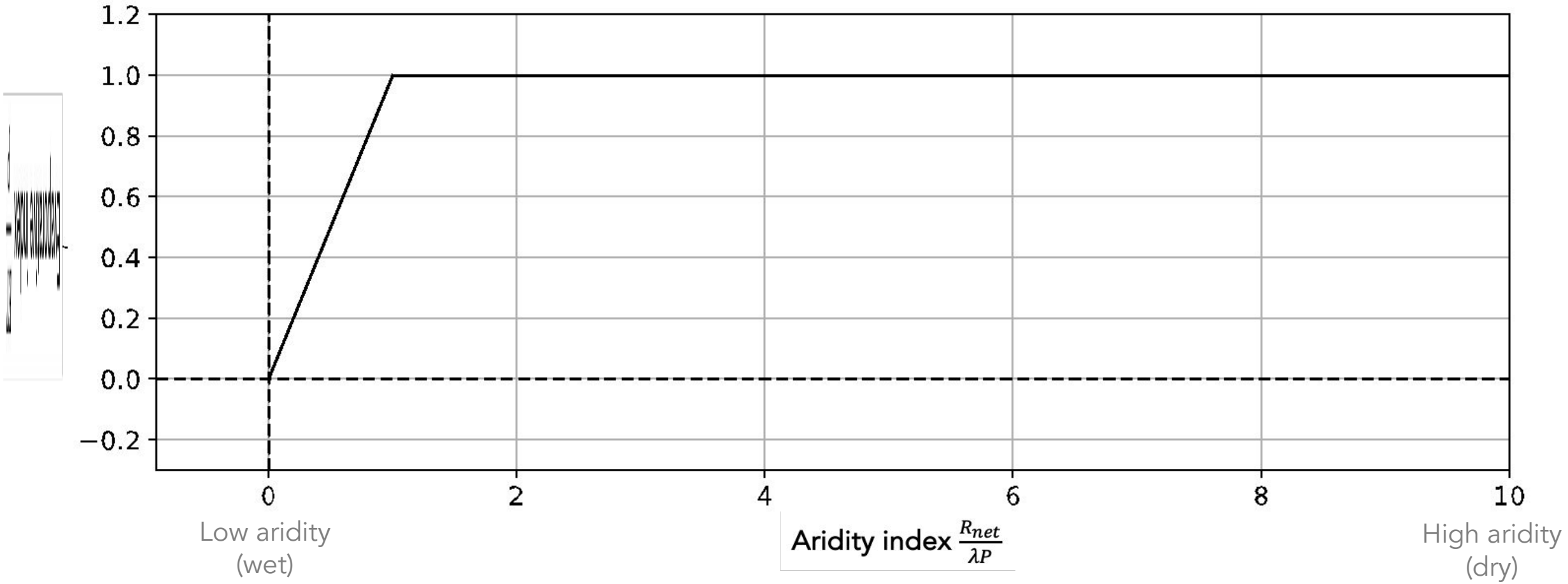


Atmospheric modulation of ET changes



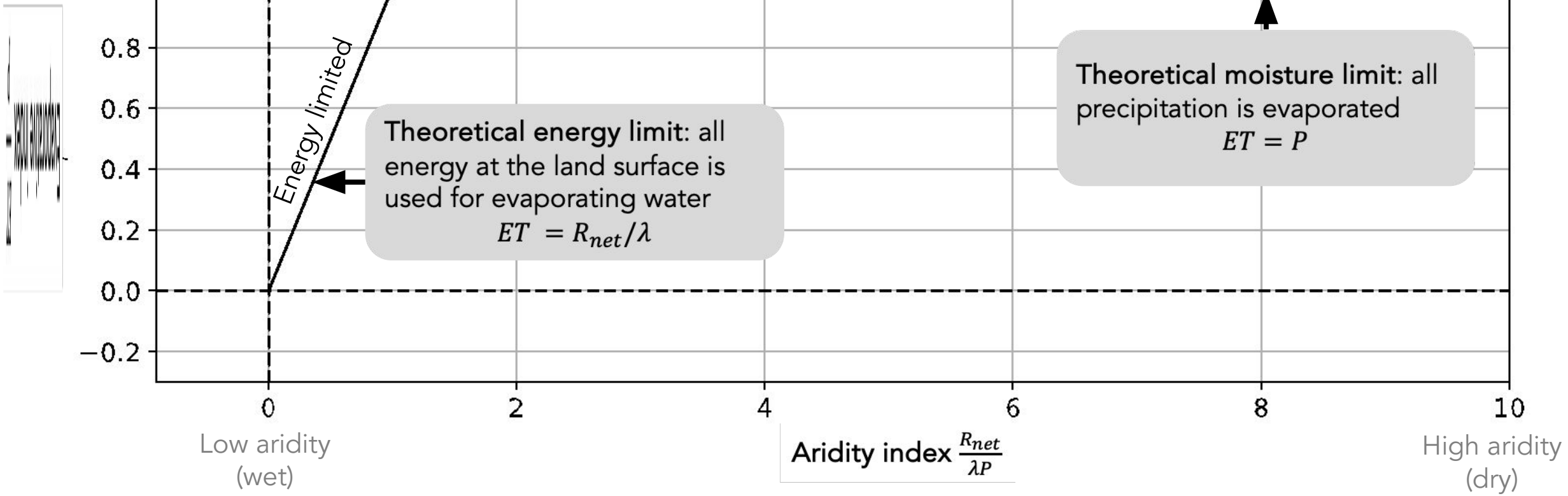
Stippling indicates not statistically significantly different from 1

Budyko (1956) conceptual framework for constraints on land ET



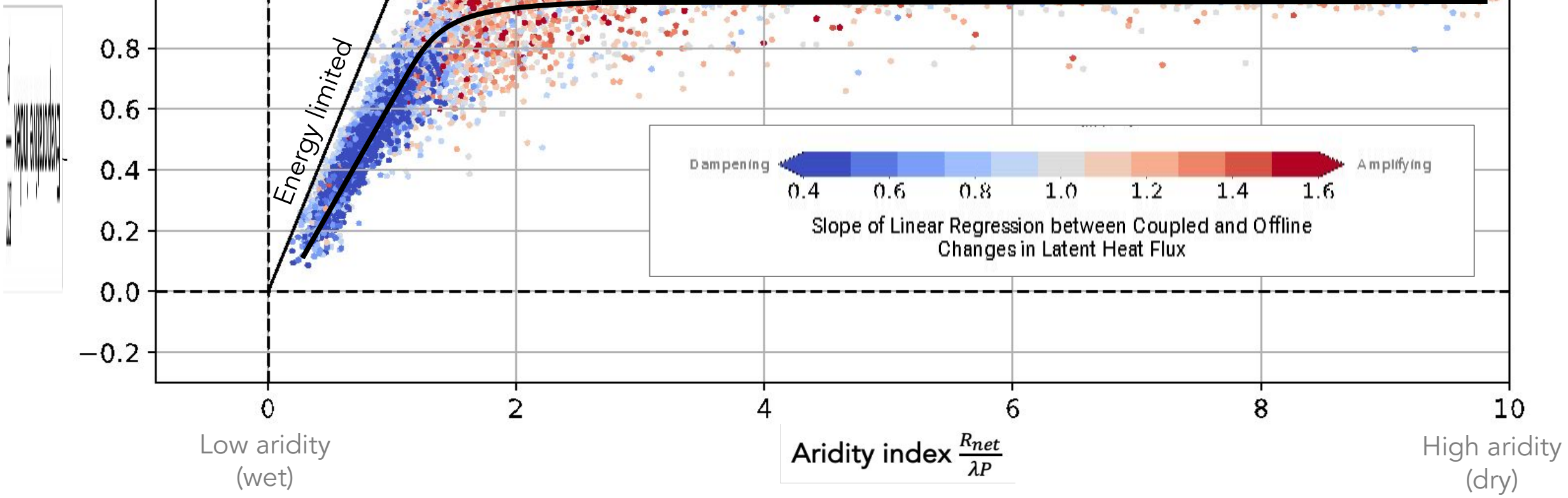
R_{net} = net radiation at the land surface; ET = evapotranspiration; P = precipitation; λ = latent heat of vaporization

Budyko (1956) conceptual framework for constraints on land ET



R_{net} = net radiation at the land surface; ET = evapotranspiration; P = precipitation; λ = latent heat of vaporization

Influence of atmospheric feedbacks depends on the climatological moisture regime



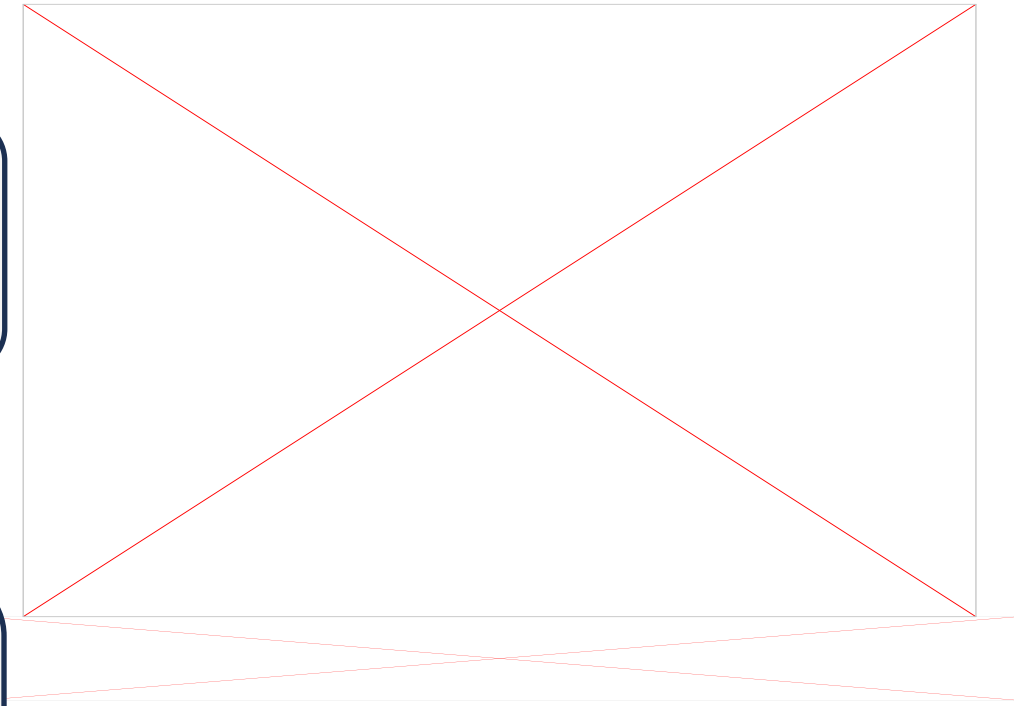
R_{net} = net radiation at the land surface; ET = evapotranspiration; P = precipitation; λ = latent heat of vaporization

Increase ET

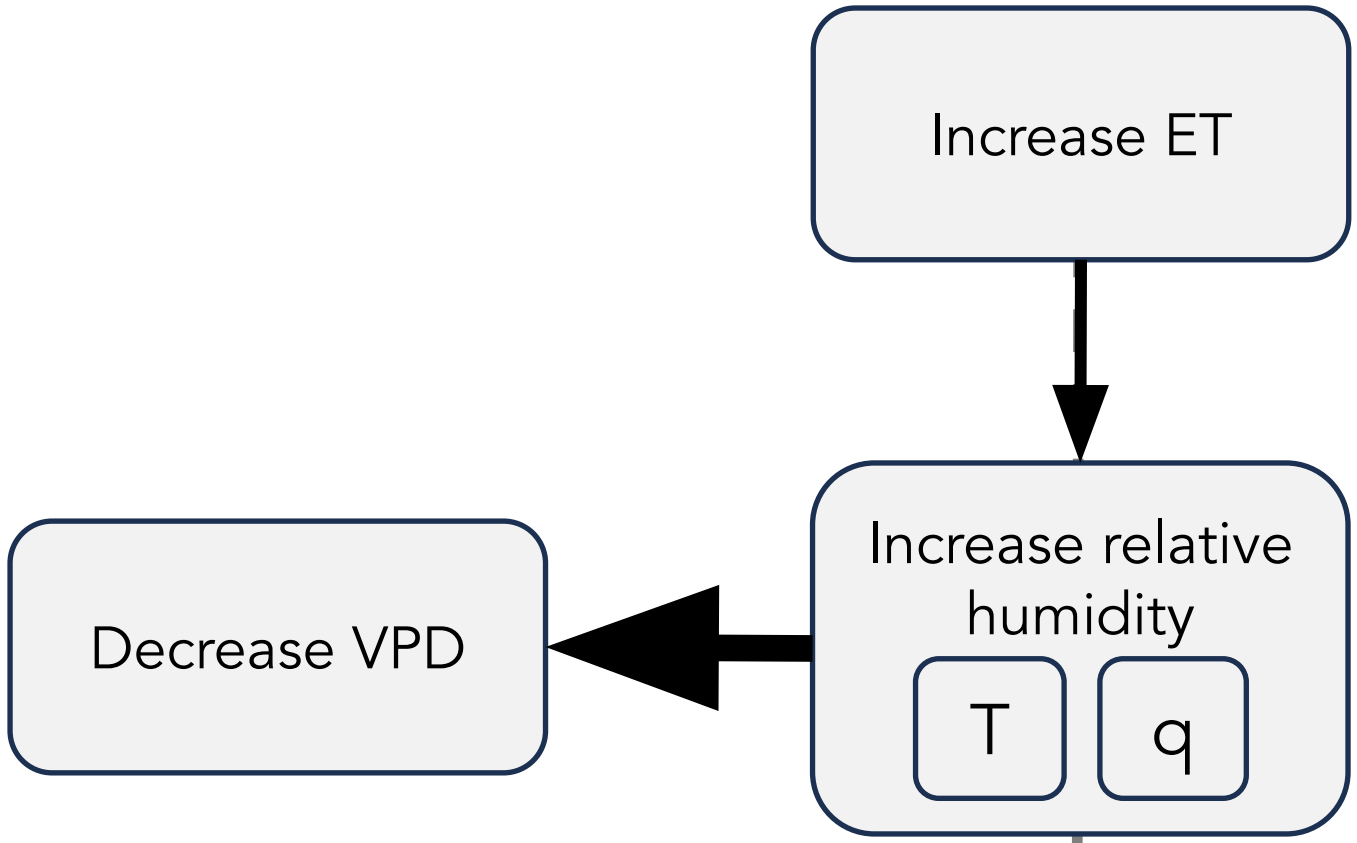
Increase relative humidity

T

q



Dominant mechanism in wet (energy-limited) regime:



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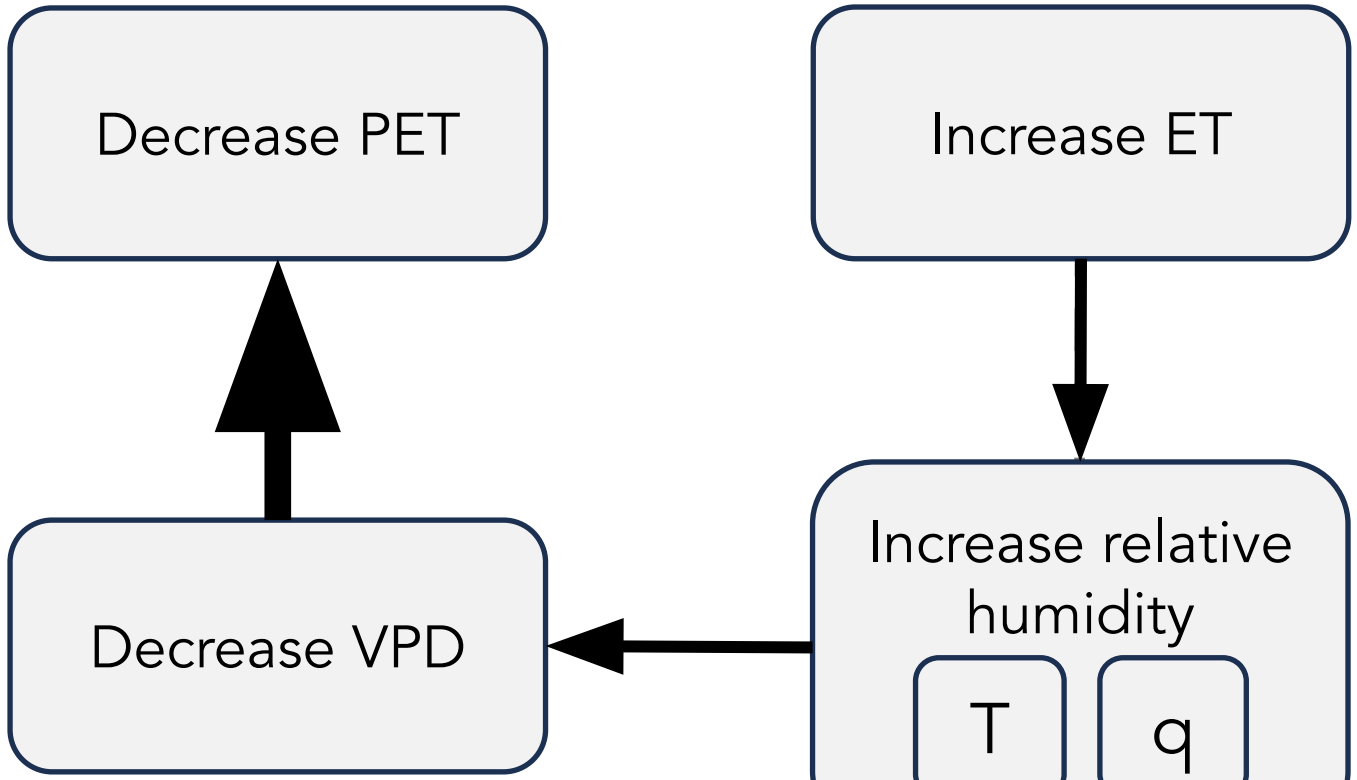

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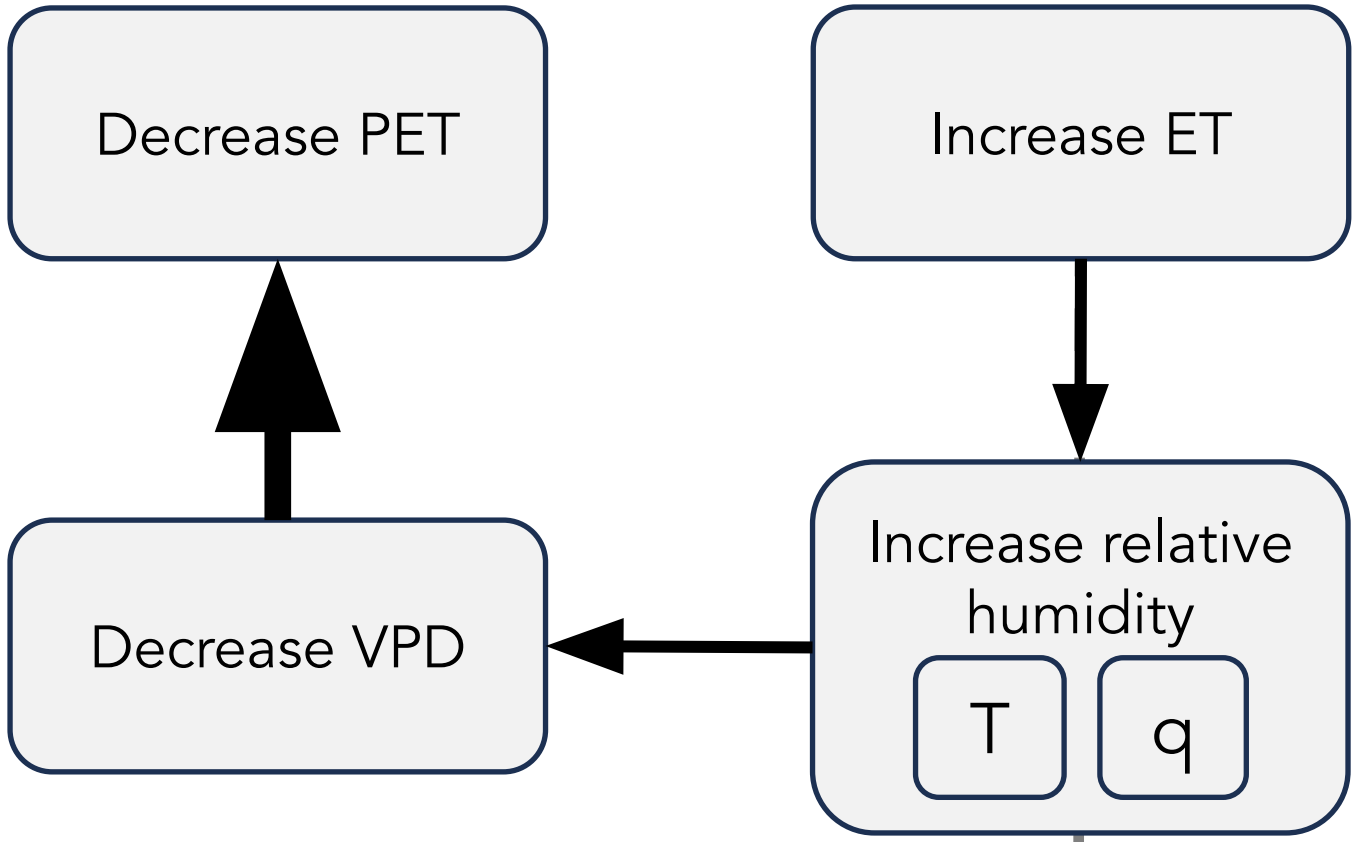

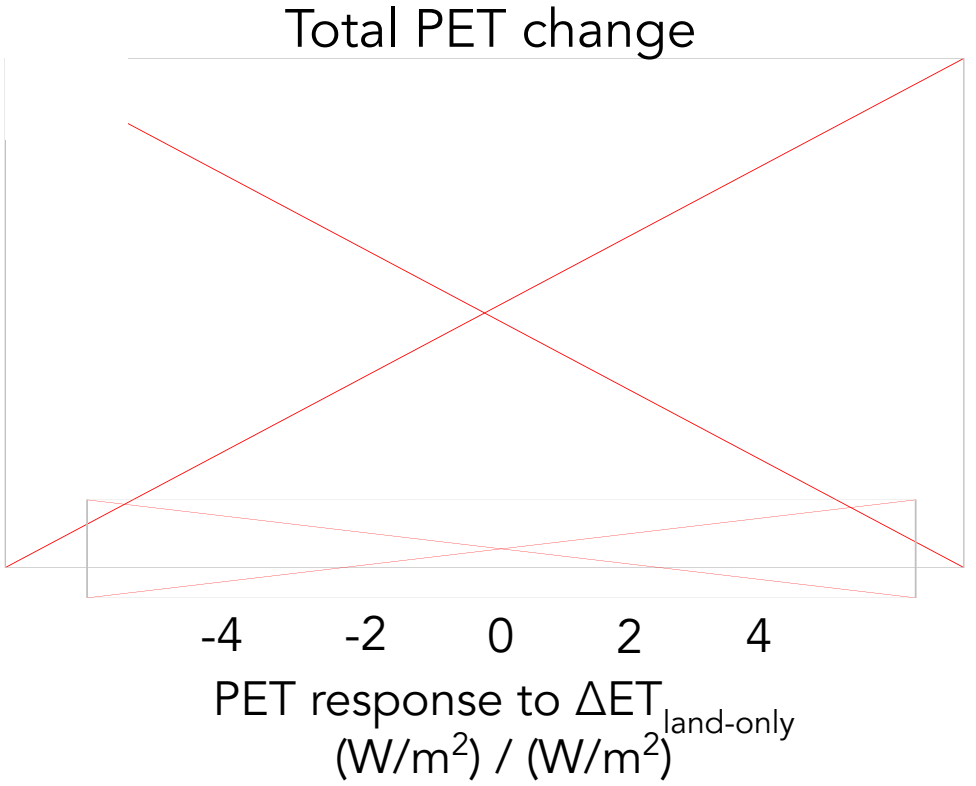

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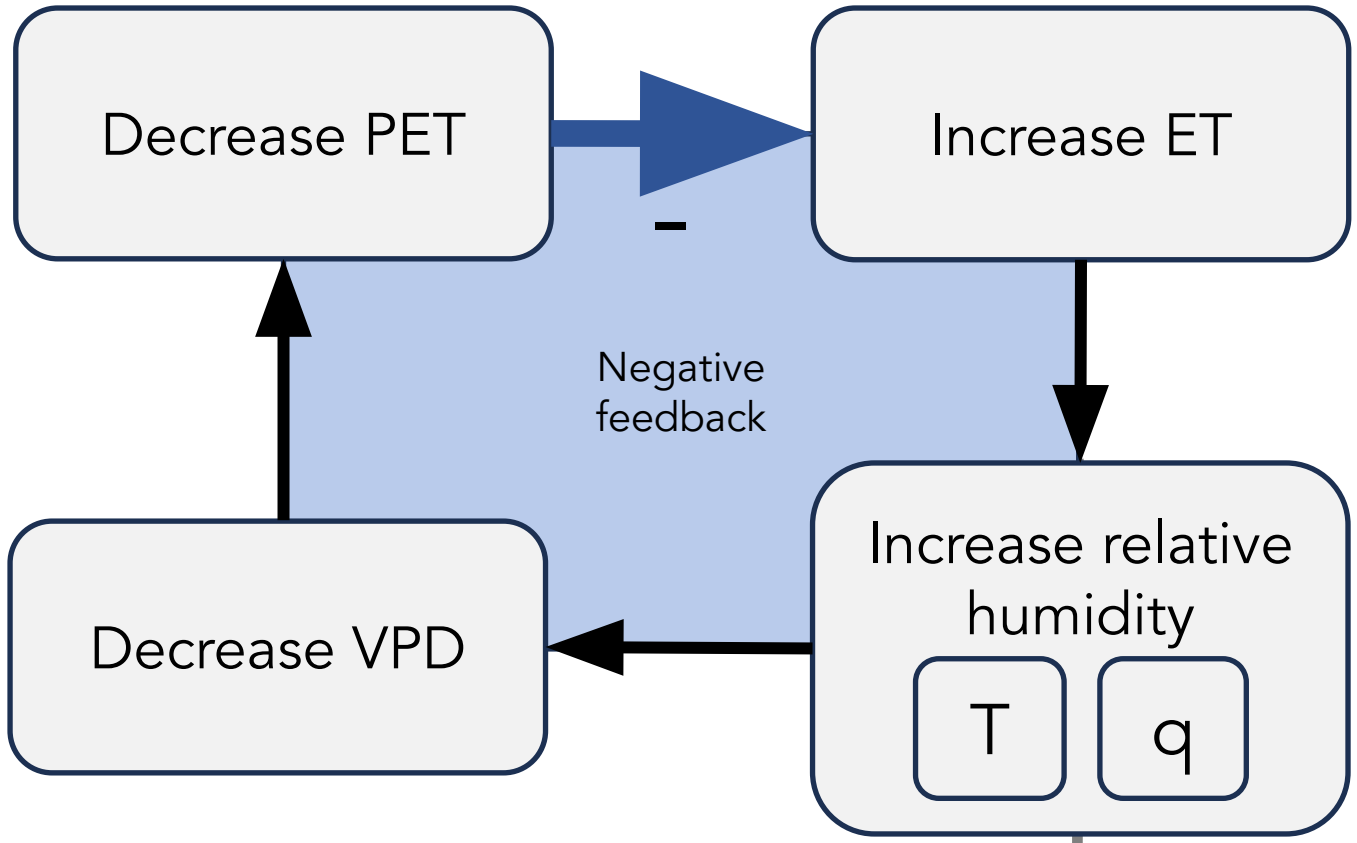

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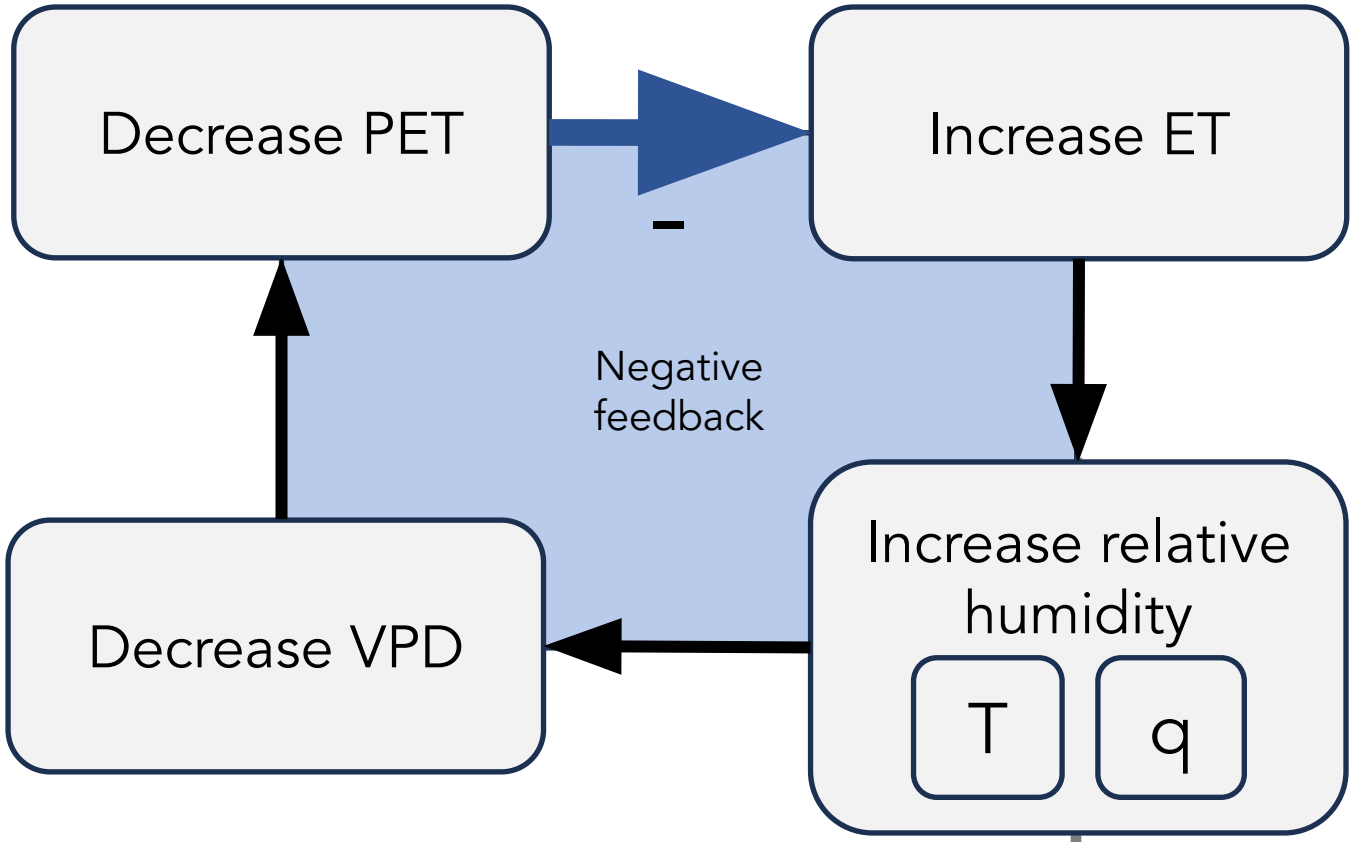
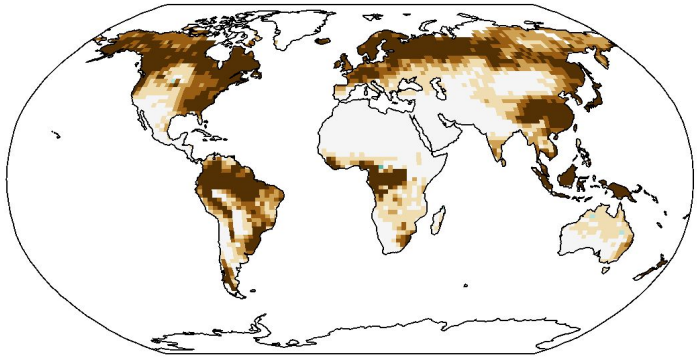
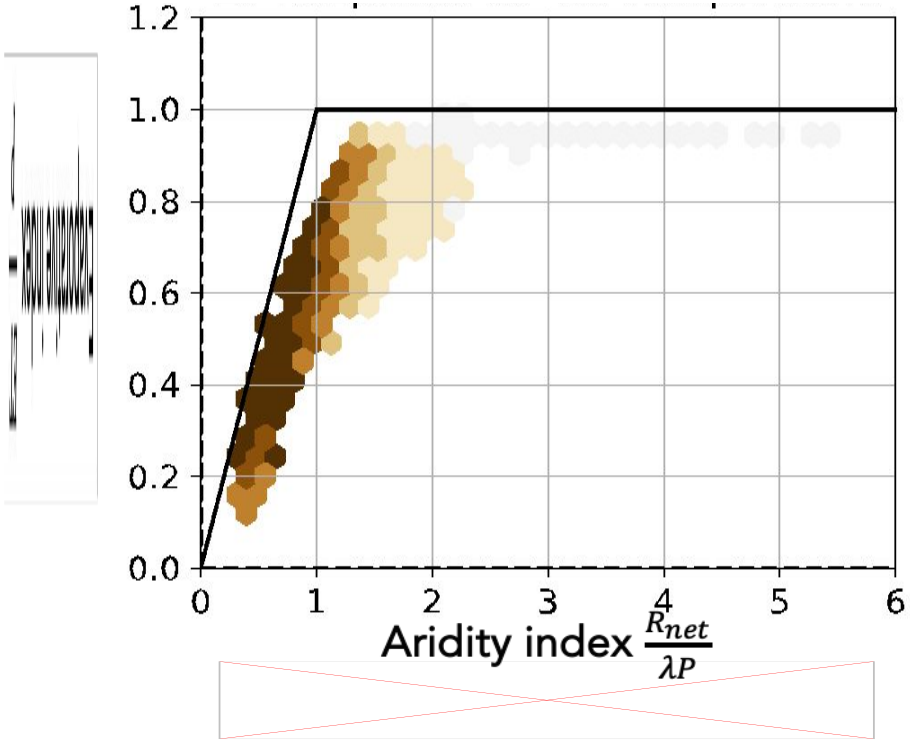
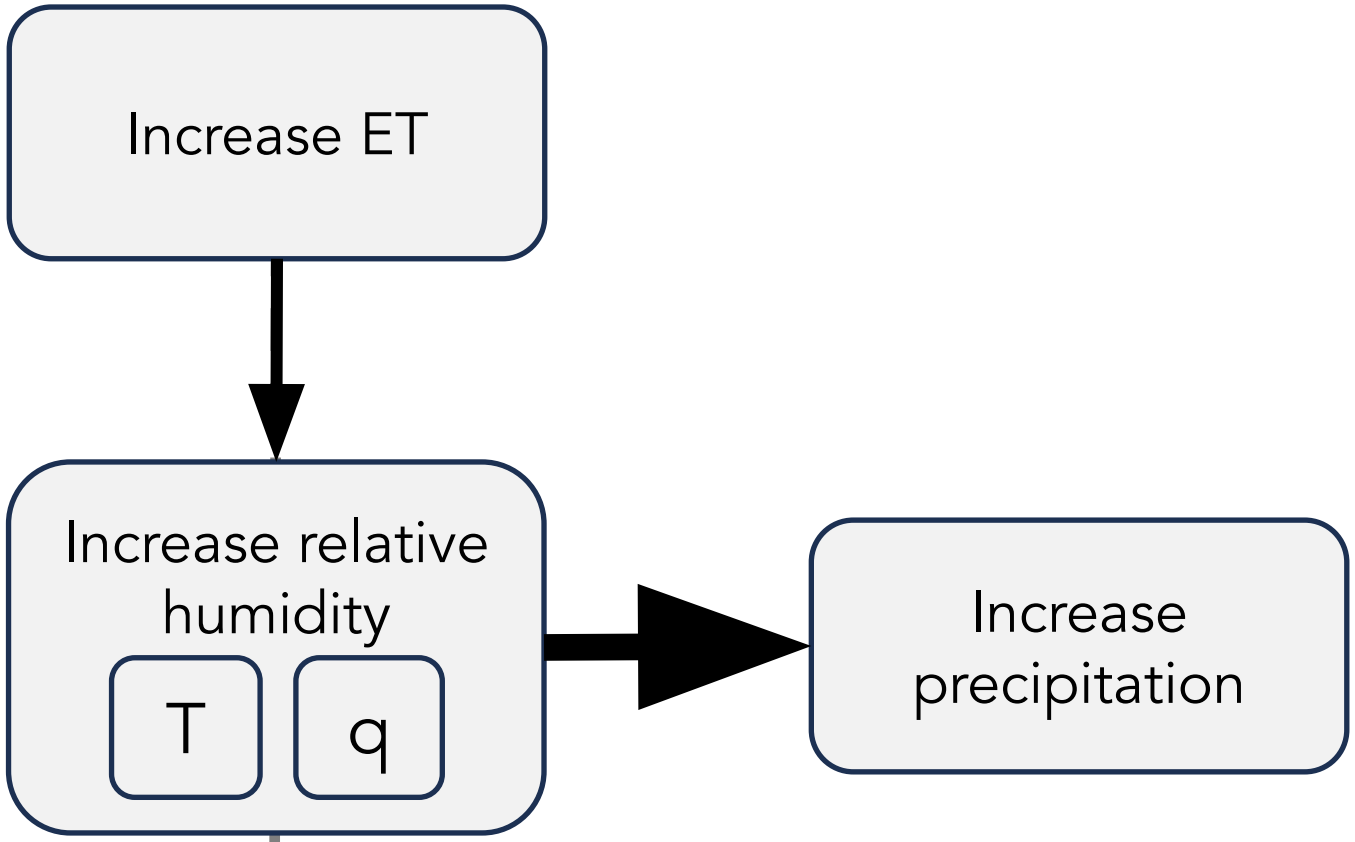


ET response to synthetic meteorology simulations that decrease PET by decreasing temperature





Dominant mechanism in dry (moisture-limited) regime:



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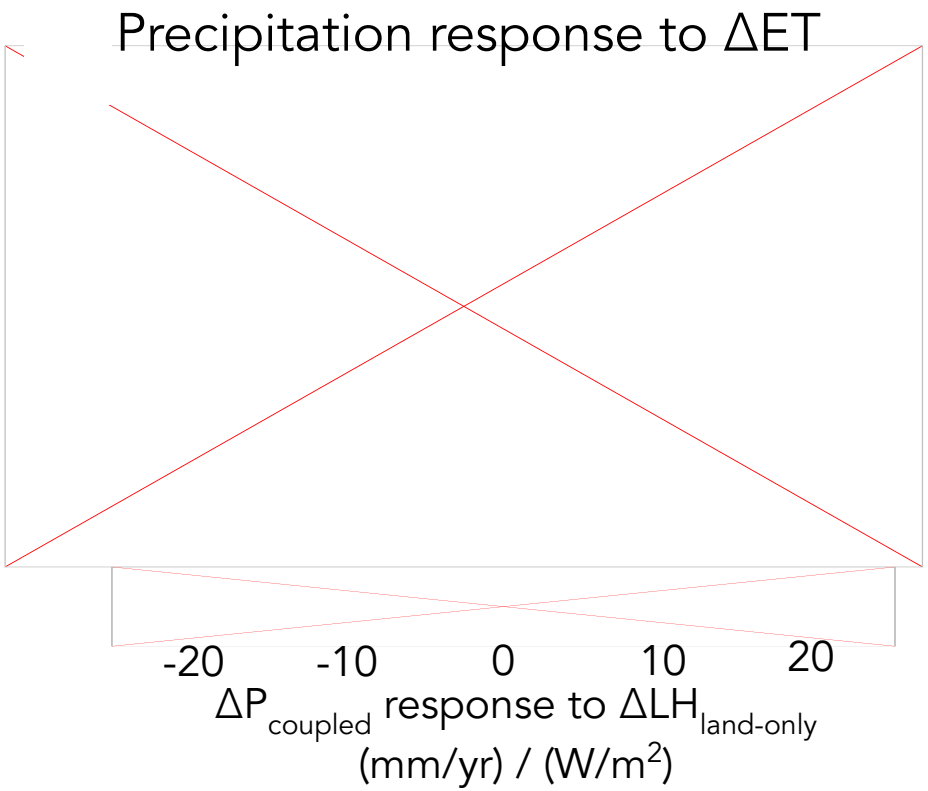

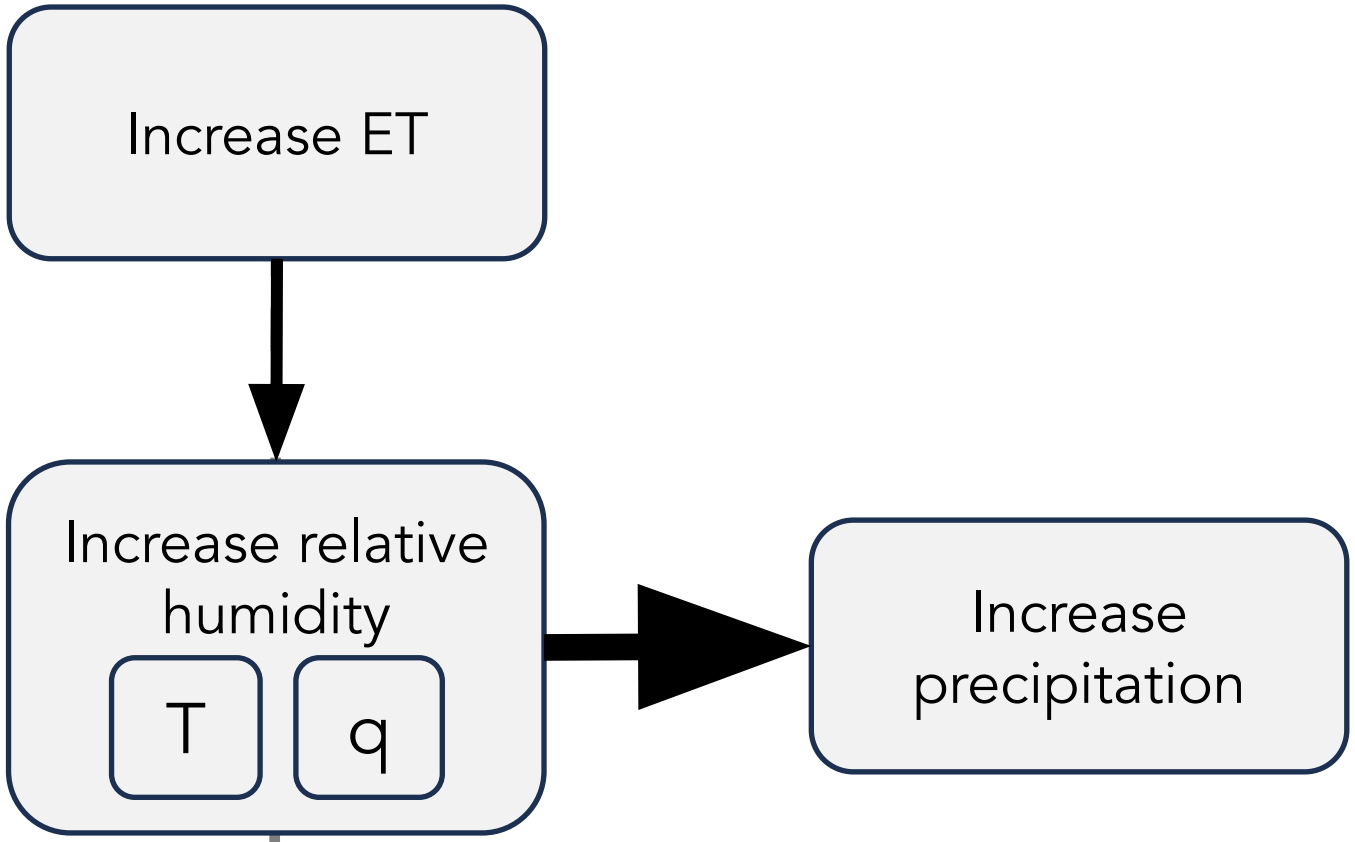

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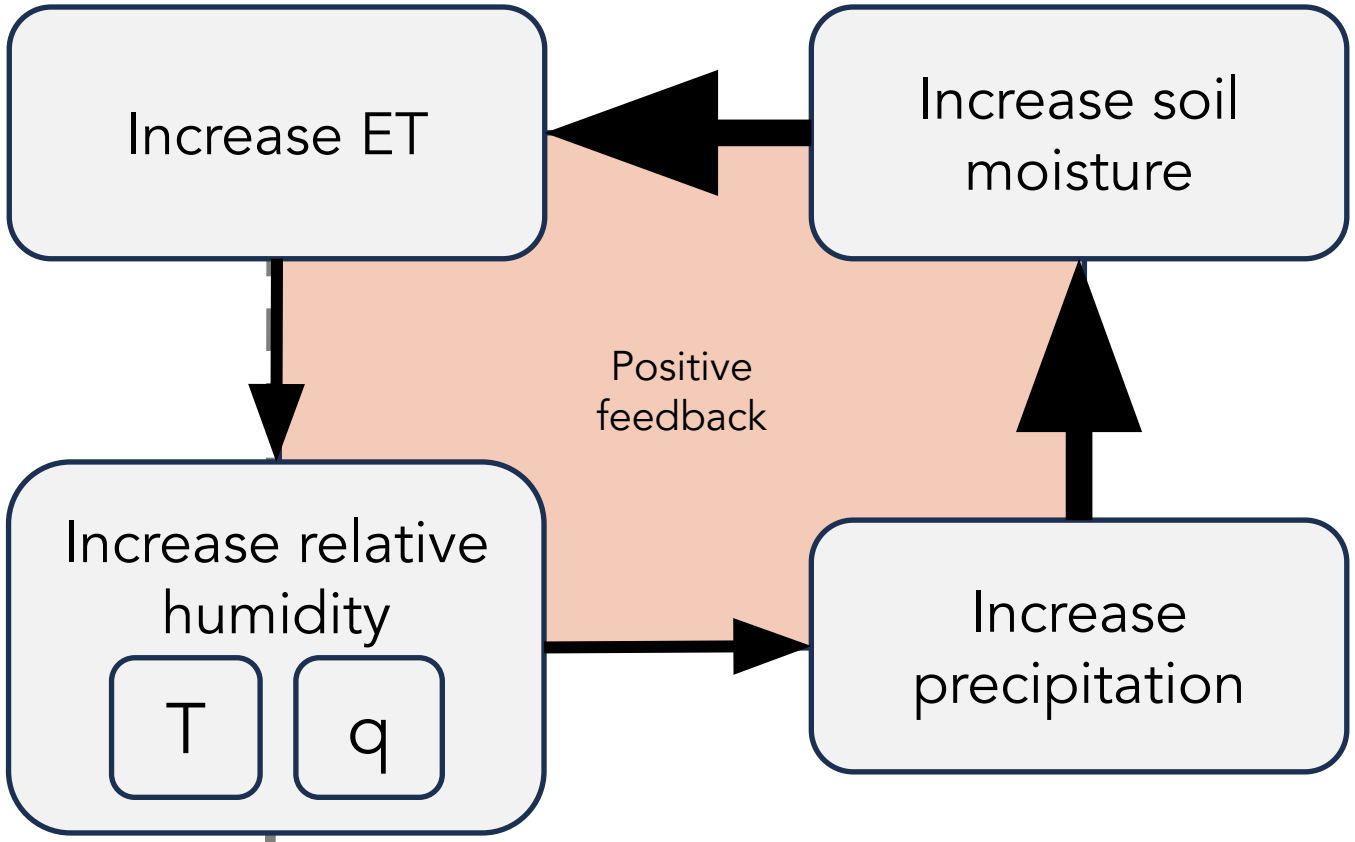
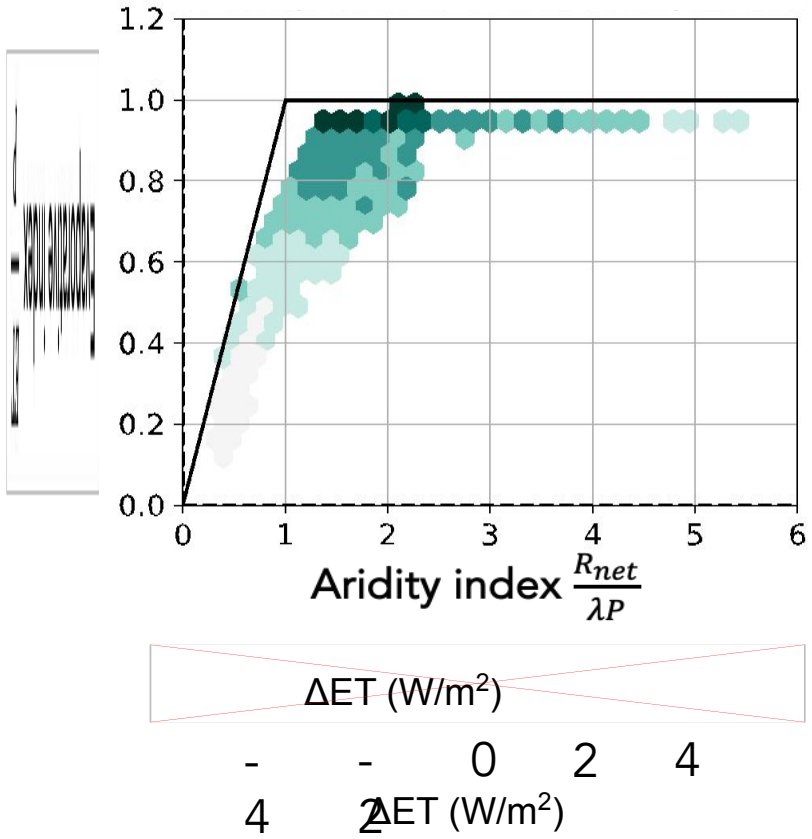
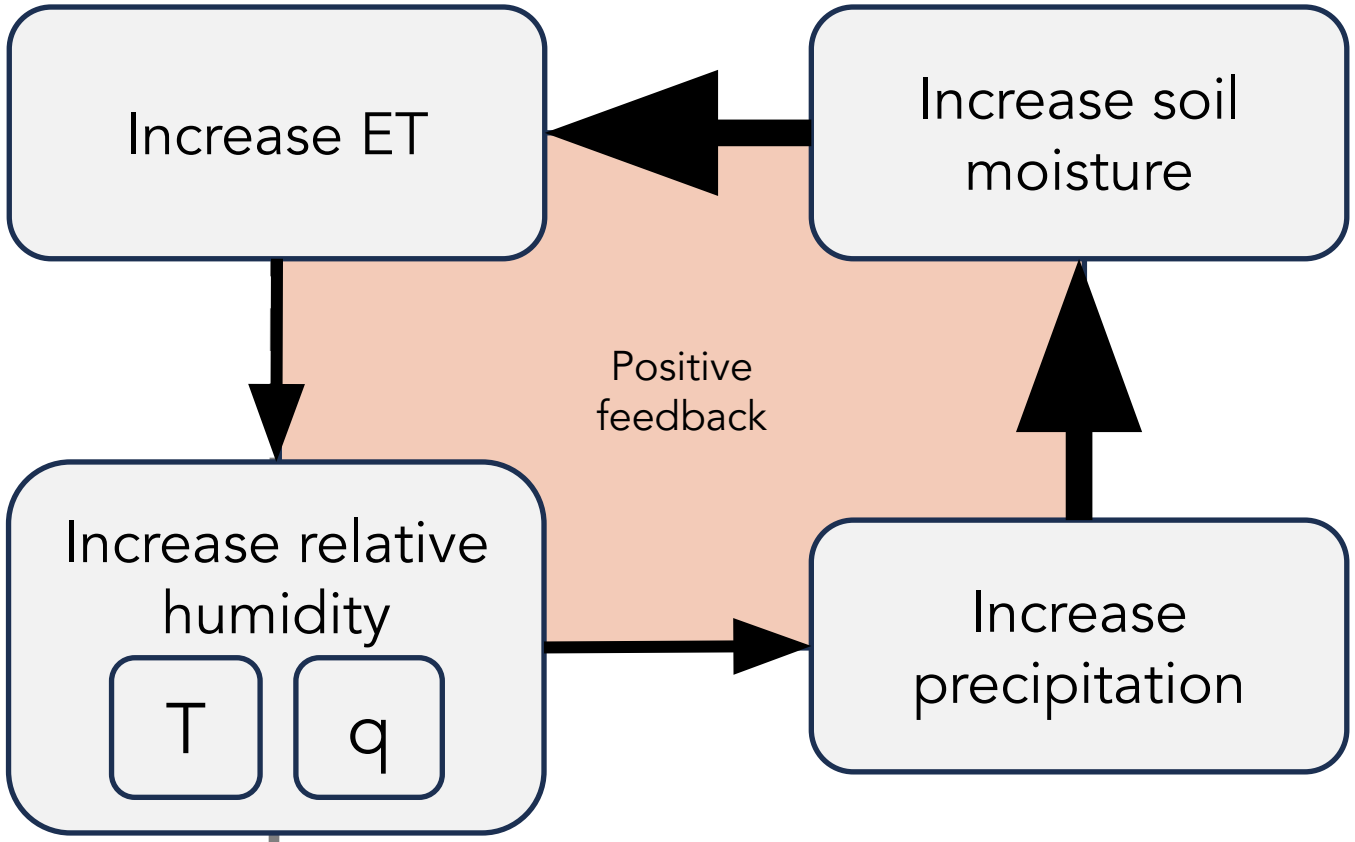


ET Response to +10% Precipitation



Dominant mechanism in dry (moisture-limited) regime:



Dominant mechanism in wet (energy-limited) regime:

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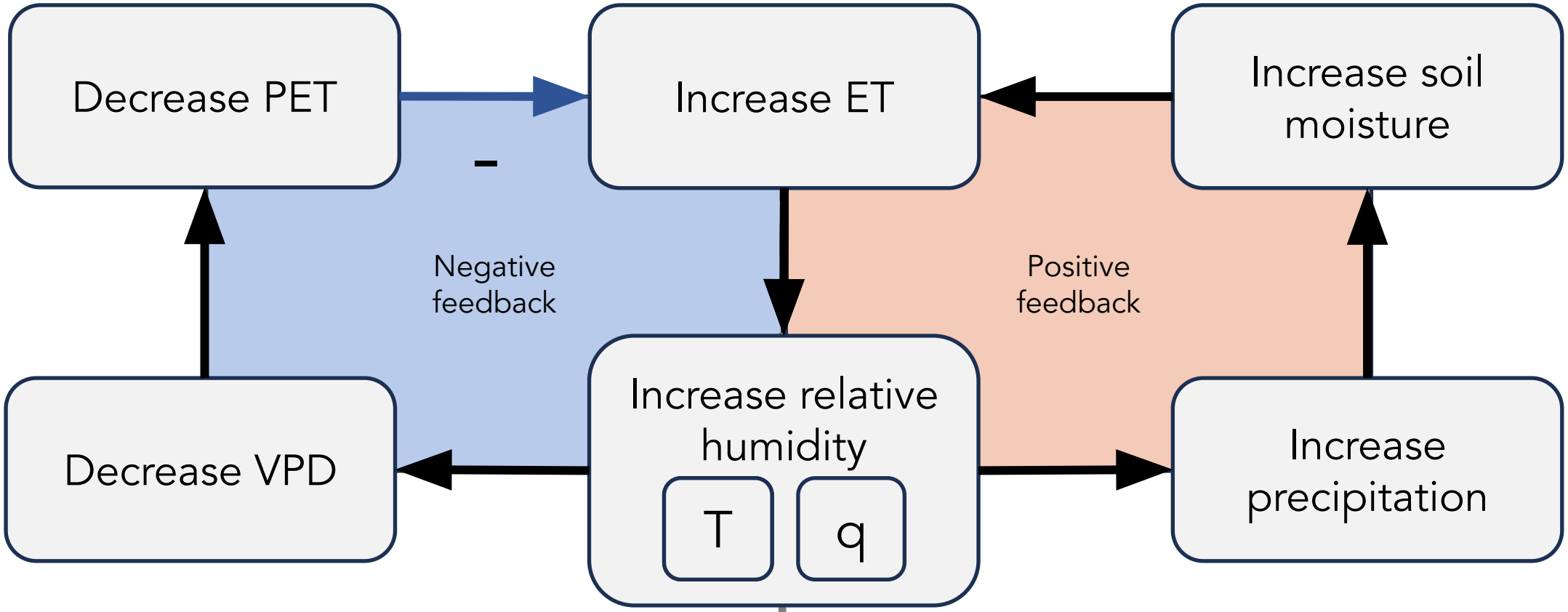
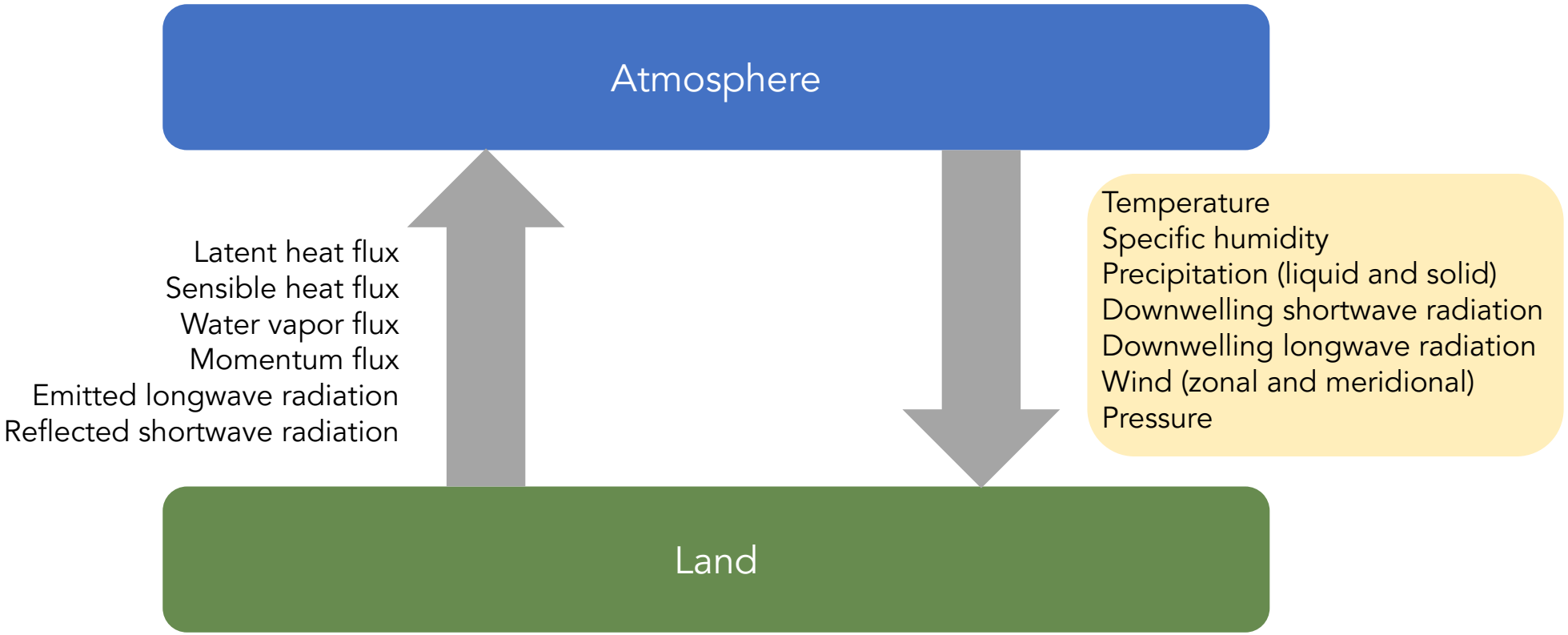


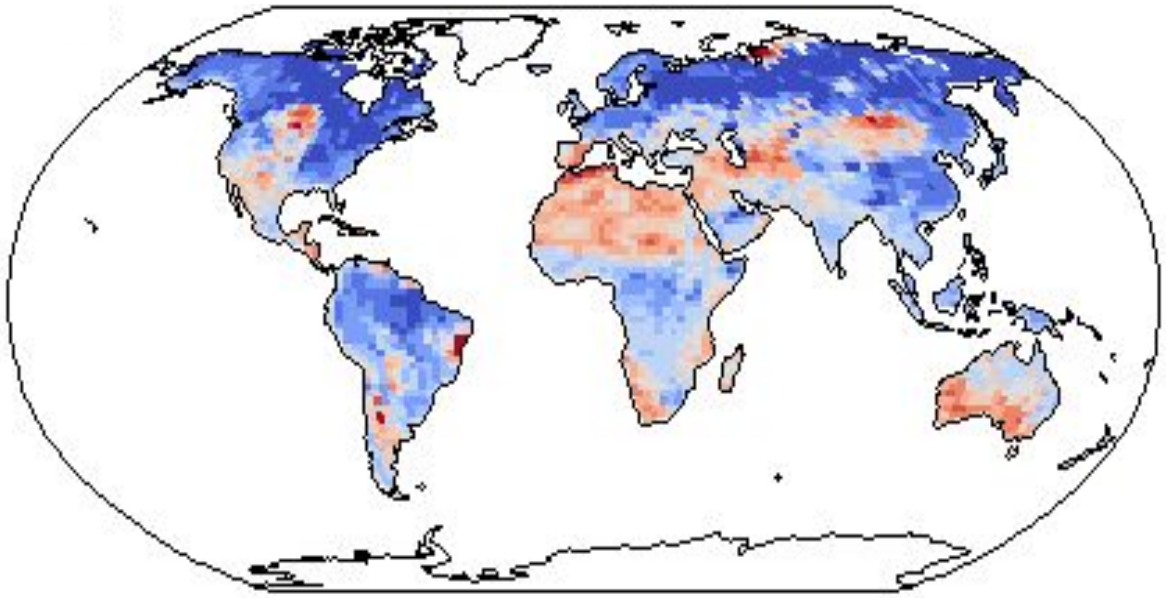
Linearly decompose different atmospheric drivers' contribution to the feedback

$$\Delta ET_{feedback} = \Delta ET_{feedback,P} + \Delta ET_{feedback,T} + \Delta ET_{feedback,q} + \Delta ET_{feedback,SW} + \ldots$$

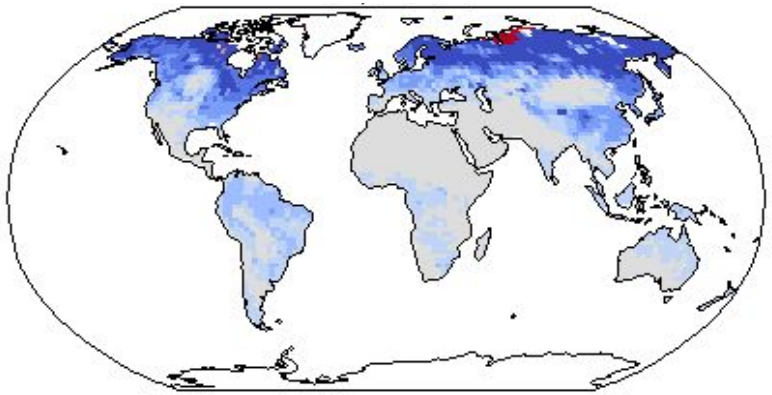


Spatial variation mostly explained by temperature and precipitation

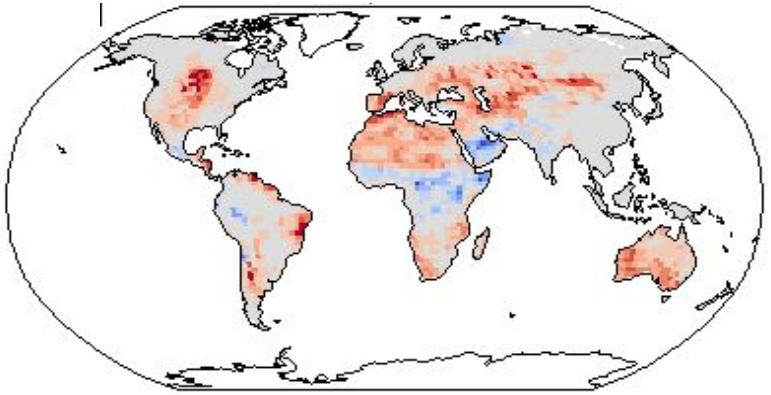
Linear Reconstruction

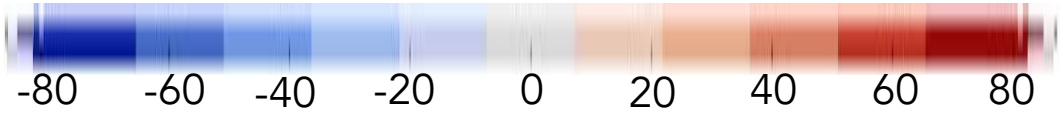


ET-Temperature Feedback



ET-Precipitation Feedback





Change in ET due to atmospheric feedbacks (%)

Land-atmosphere feedbacks dampen ET changes in energy-limited regions and amplify ET changes in some moisture-limited regions

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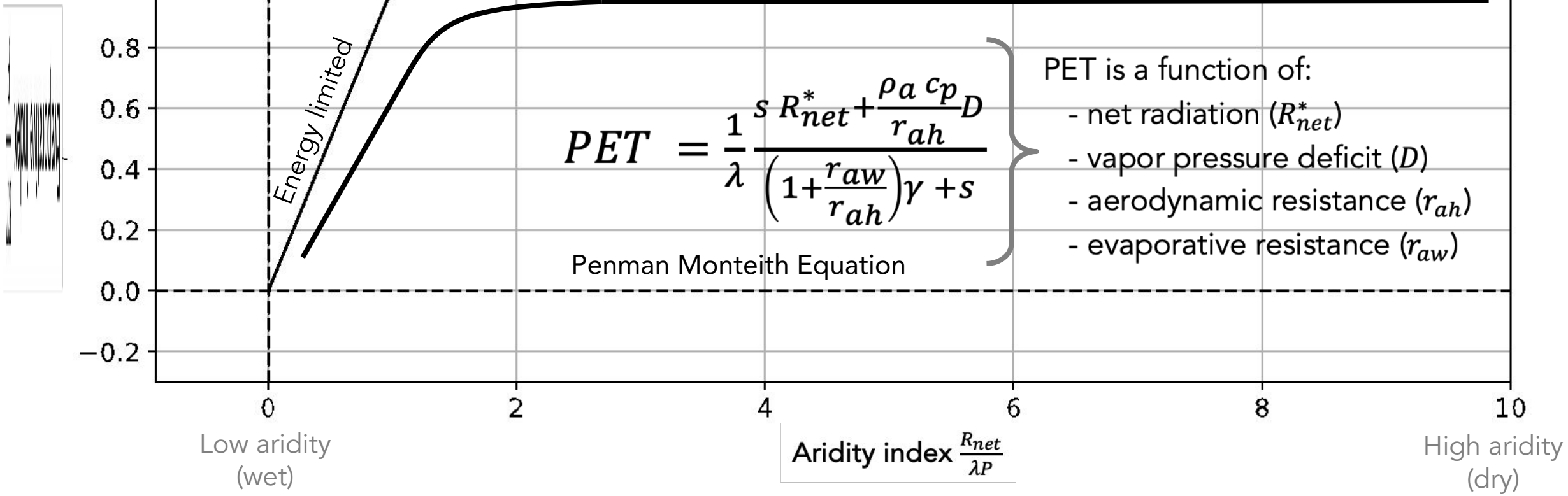
Claire Zarakas
claire.zarakas@gmail.com

Potential evapotranspiration (PET) depends on more than net radiation

Distribution of all land grid cells in our reference simulation in Budyko space



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