SLIM: a simple land model for CESM

(The Simple Land Interface Model)

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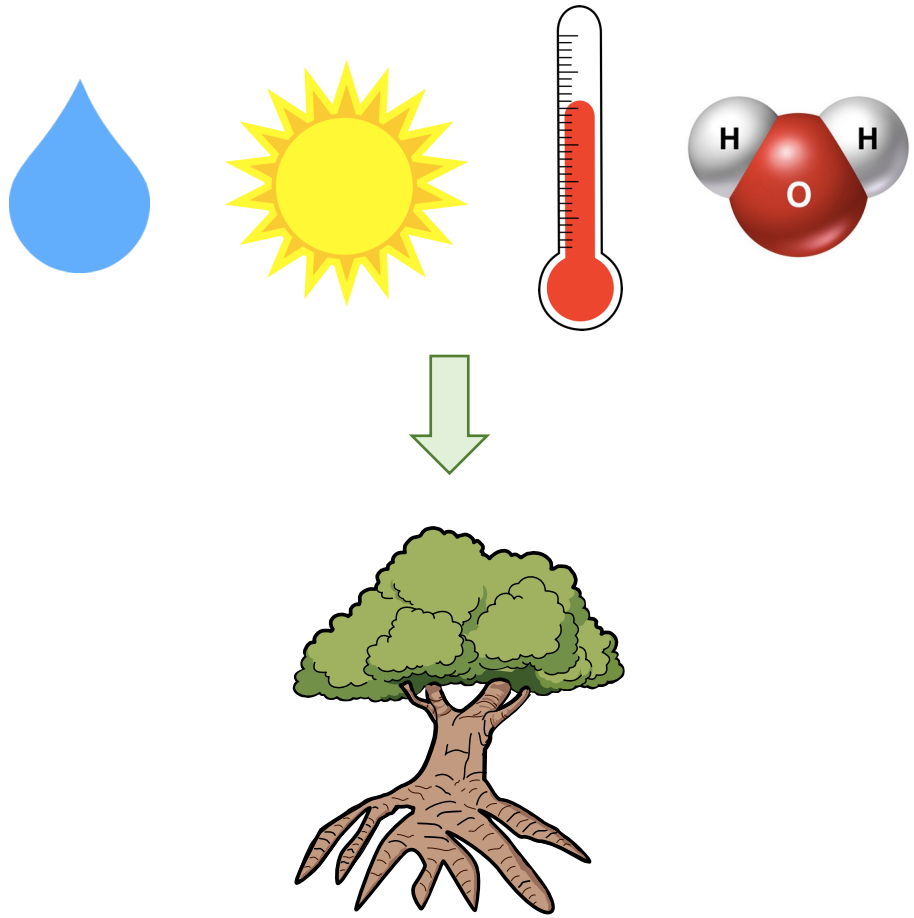
Why did we want a simpler land model?

Why did we want a simpler land model?

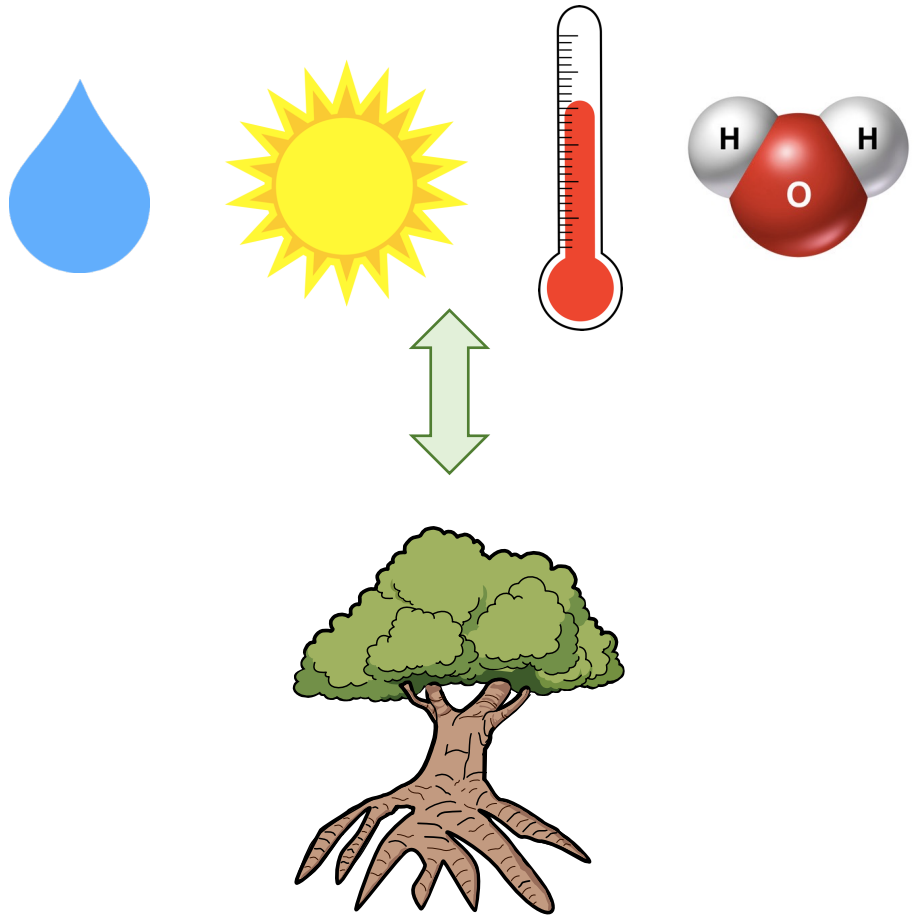
- To identify where the atmosphere is most sensitive to changes in the land surface
- To see which surface properties matter most at any given location.
- To untangle the physical pathways through which the land can influence the atmosphere.

The state of the atmospheres impacts the land surface



The state of the atmospheres impacts the land surface

Changes in the land surface drive responses in the atmosphere



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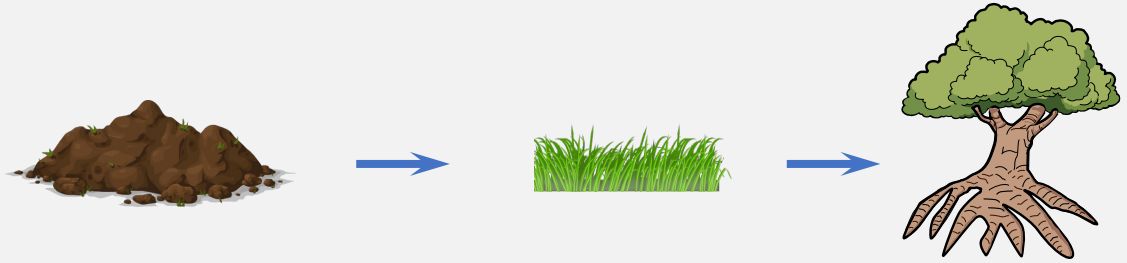
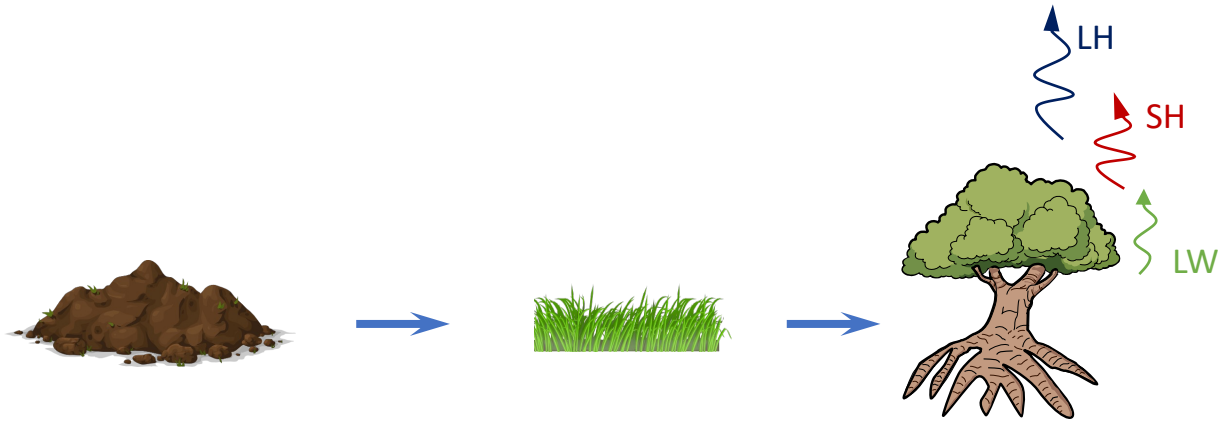


Changes in the land surface drive responses in the atmosphere

Δ Surface
Energy Fluxes



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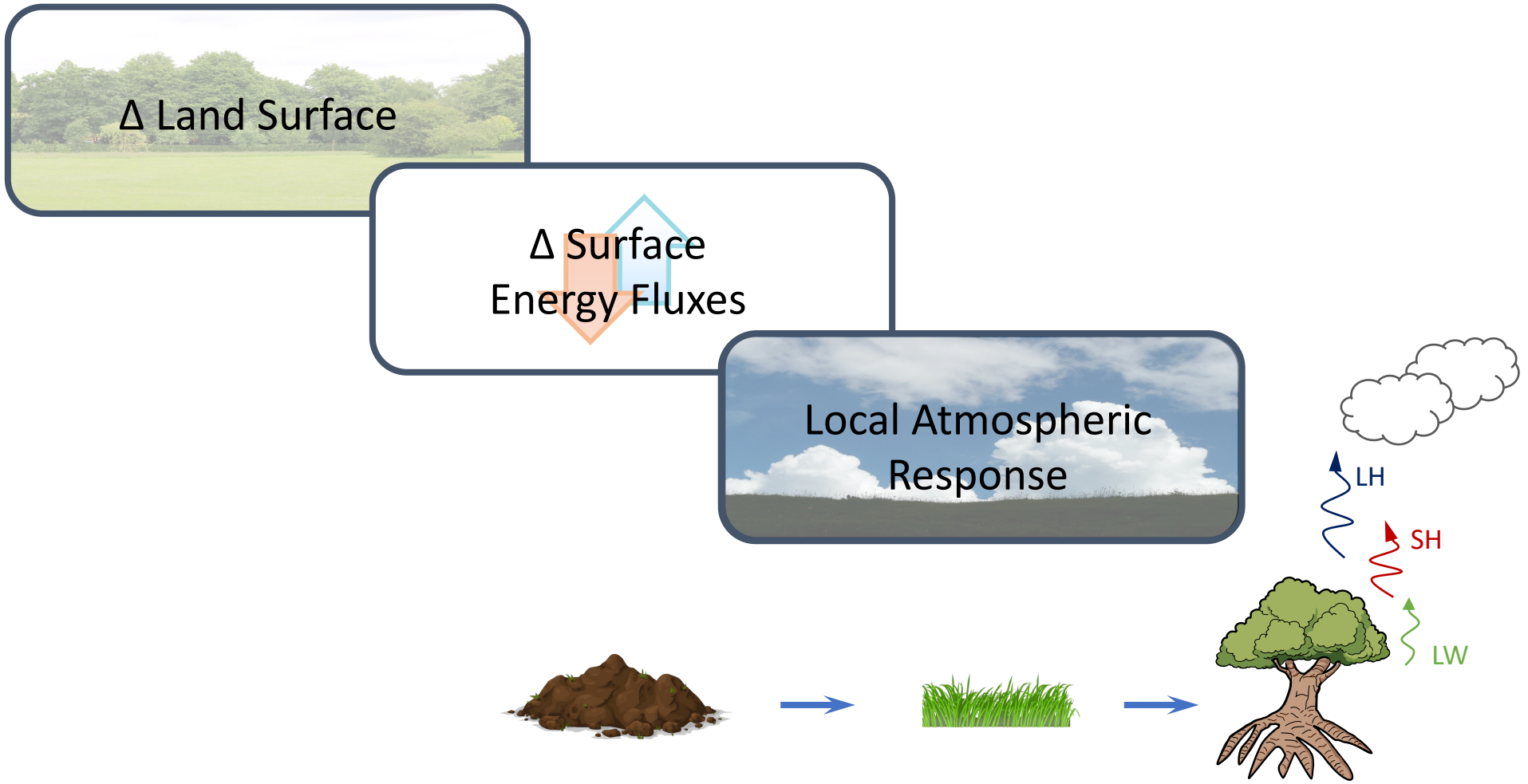

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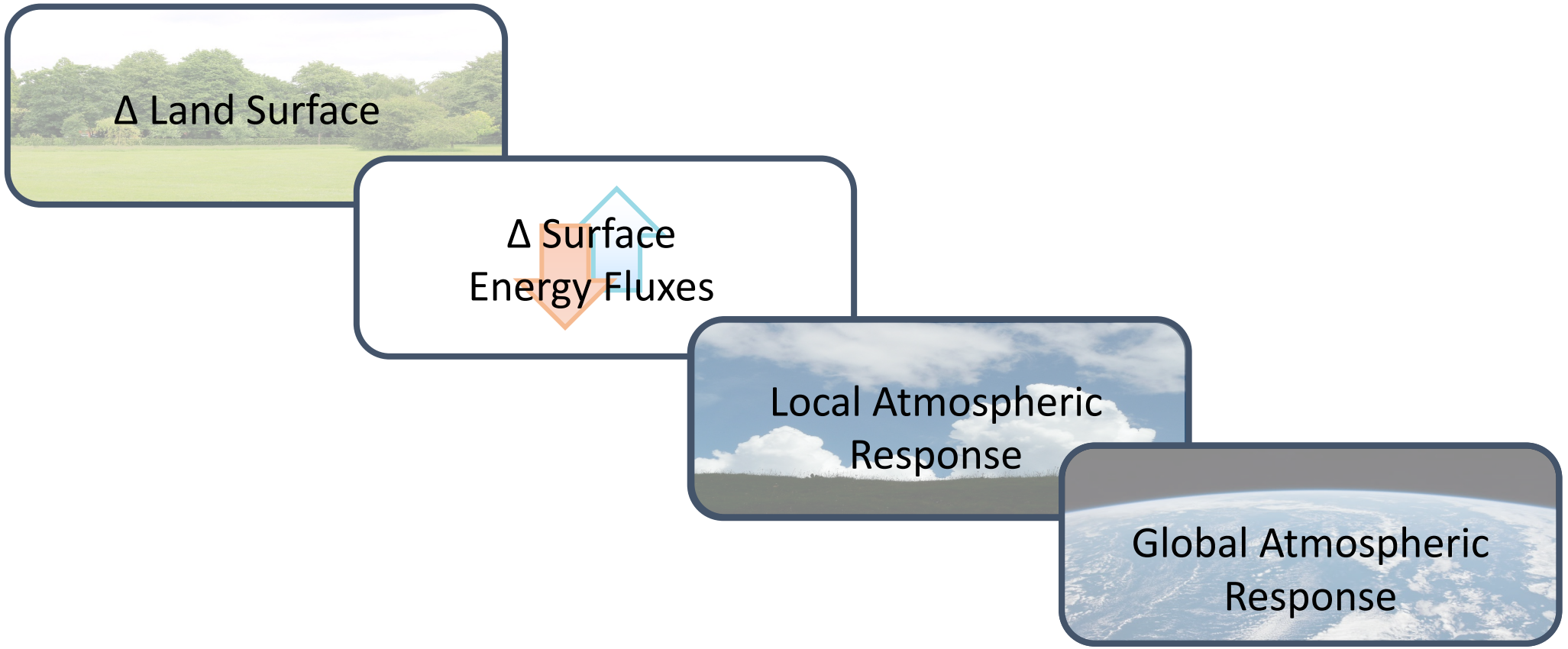

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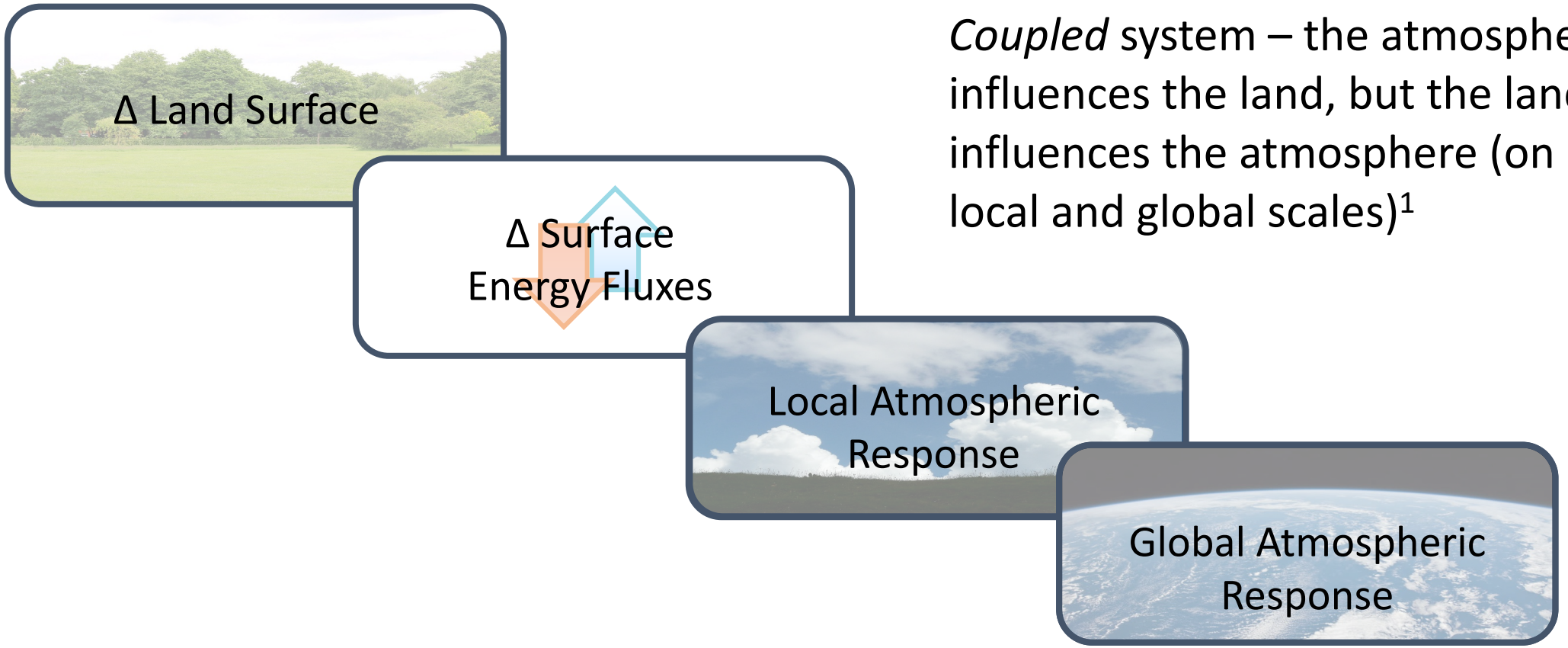
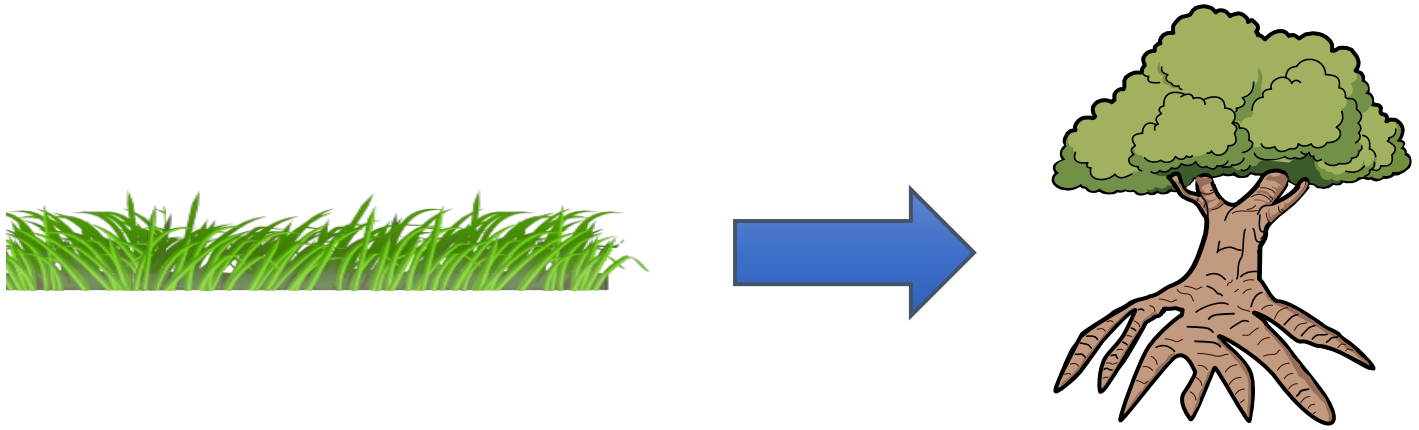


Coupled system – the atmosphere influences the land, but the land also influences the atmosphere (on both local and global scales)[1]

Changes in vegetation have been shown to drive large atmospheric responses

However, using complex land models, it can be difficult to understand exactly why some observed atmospheric response came about.

Converting grasslands to forests involves several biophysical modifications:



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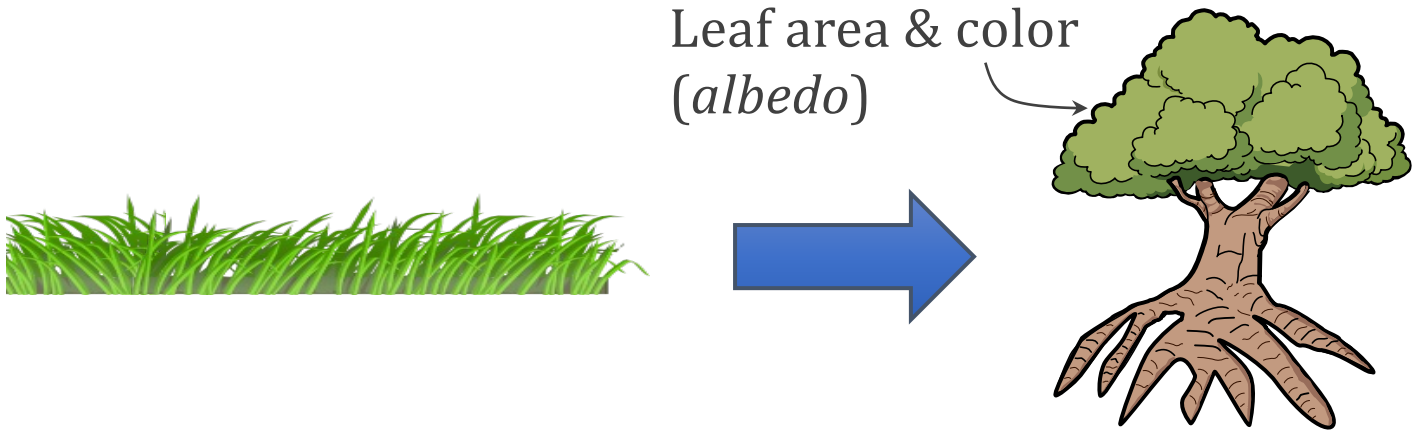

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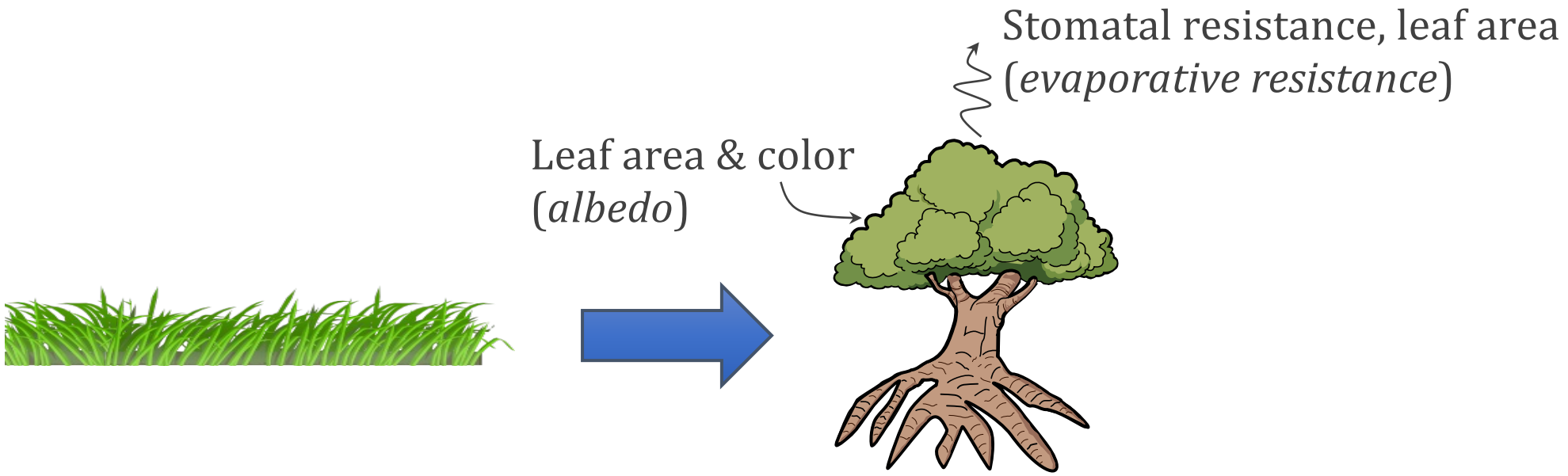

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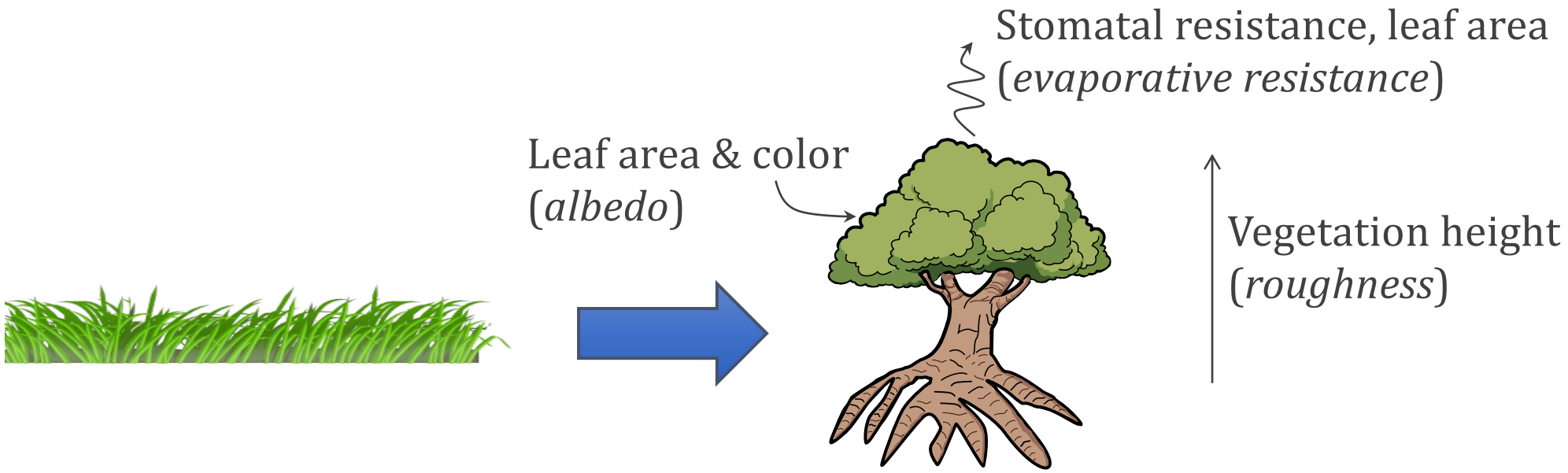

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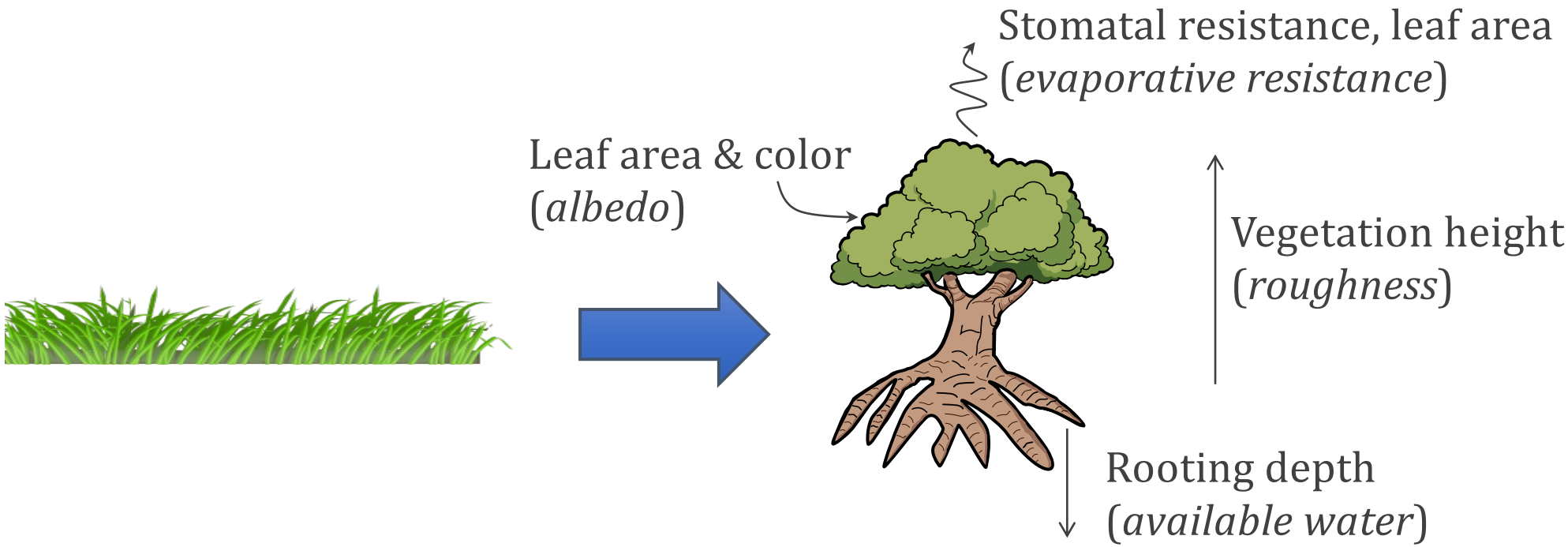

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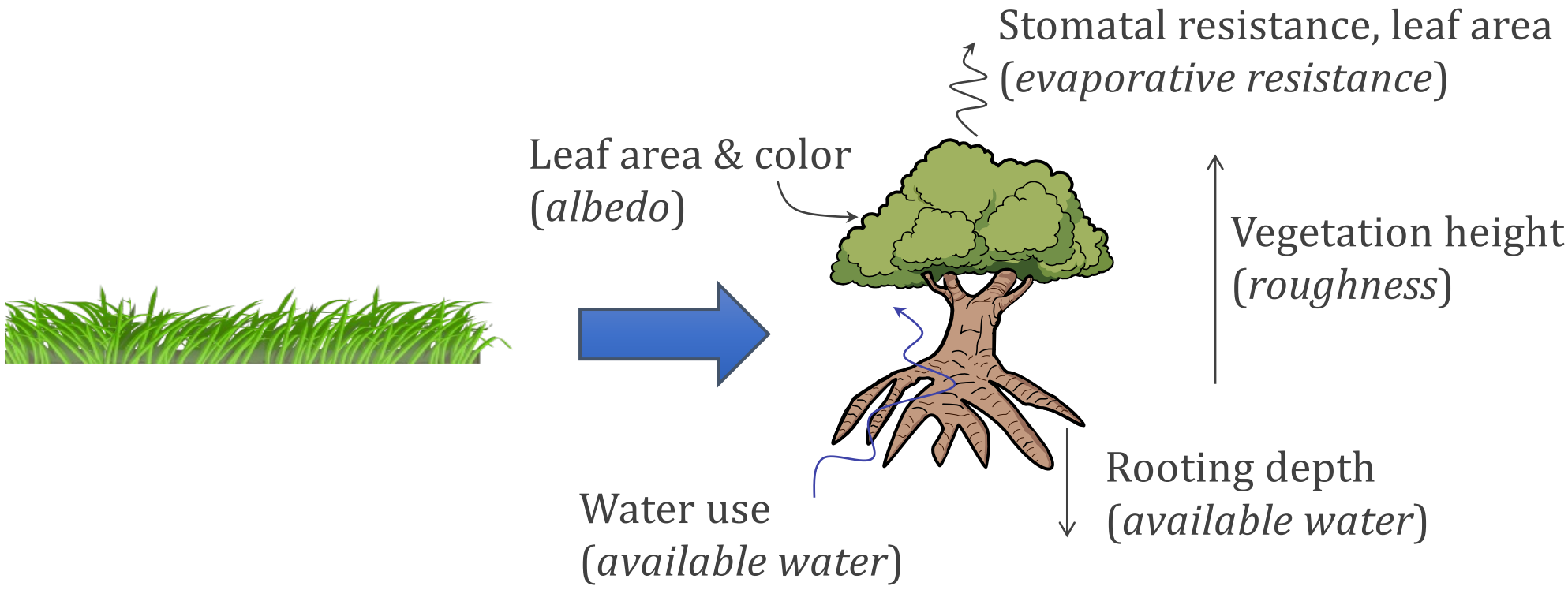
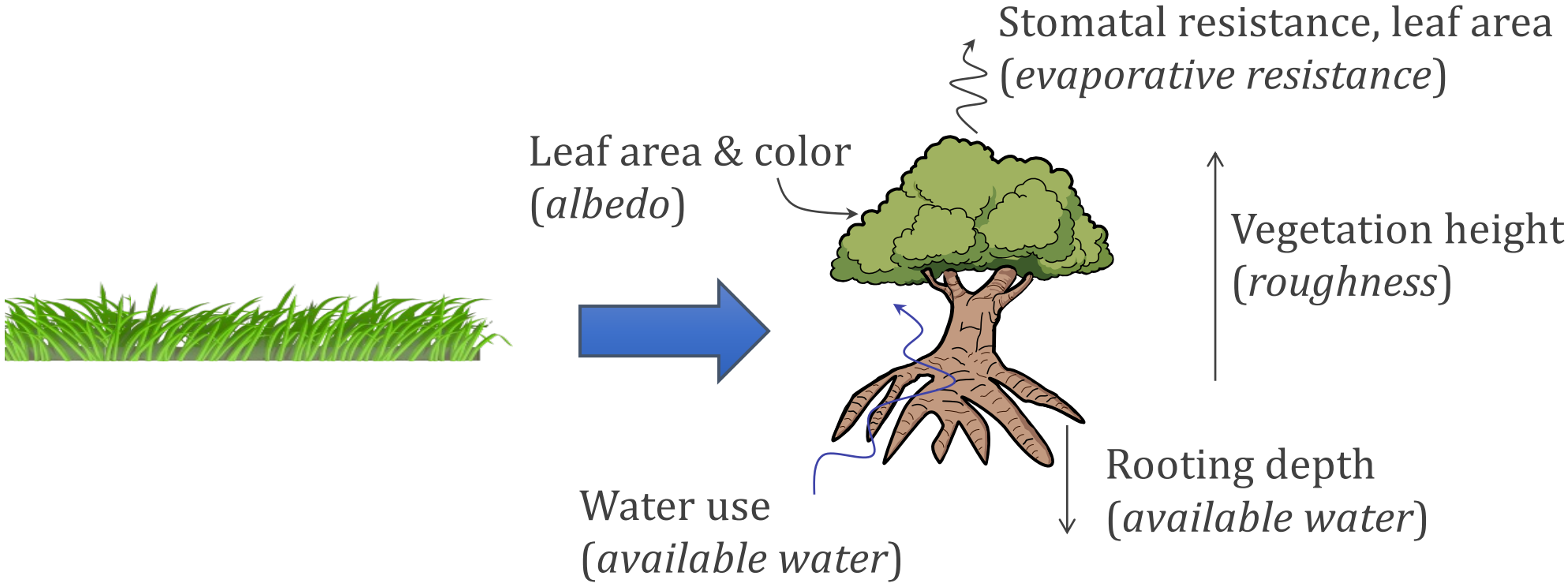


Suppose we did this experiment and got a big increase in cloud cover. Why?

Warmer, darker surface = more uplift? Rougher surface = more mixing? Higher transpiration = more humid?



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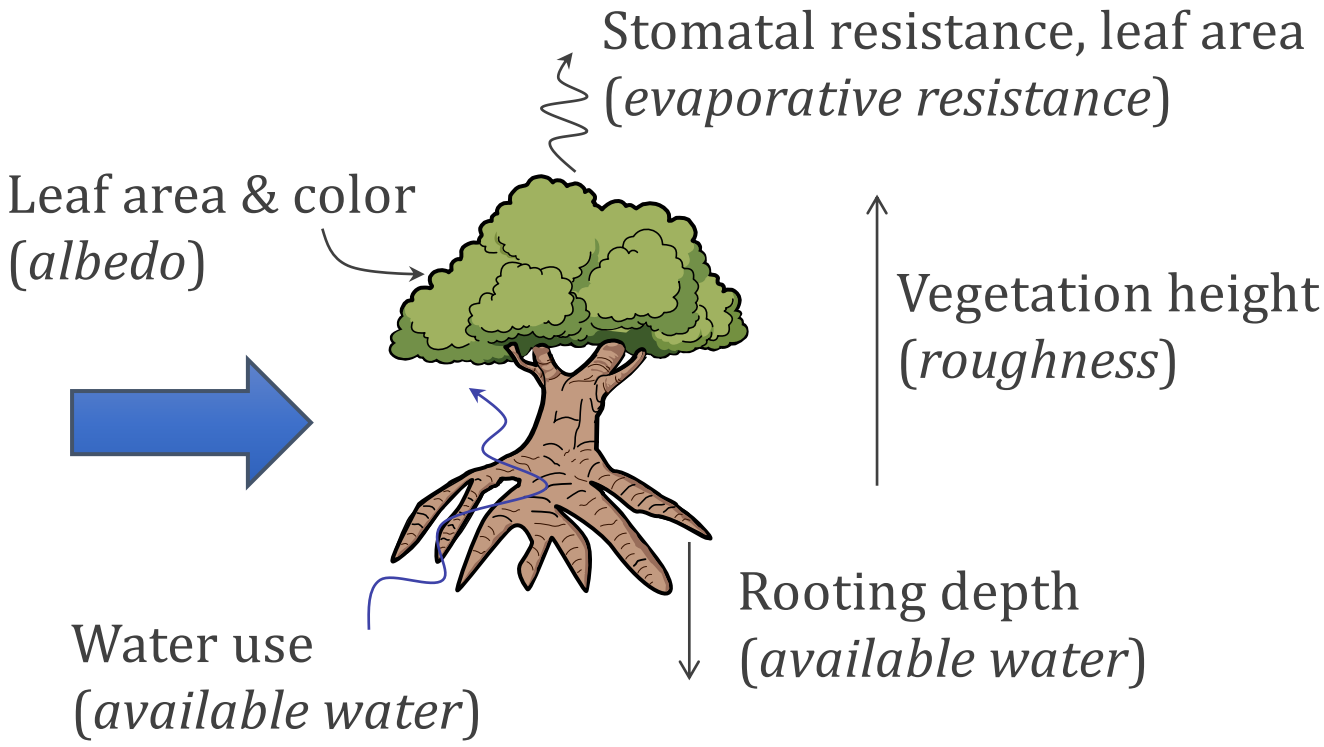
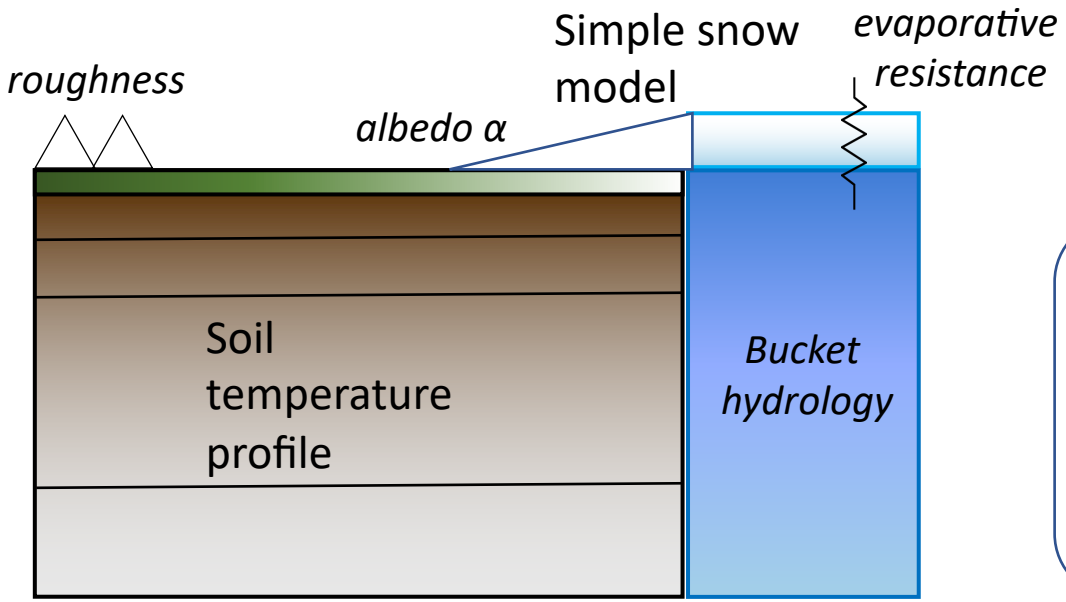
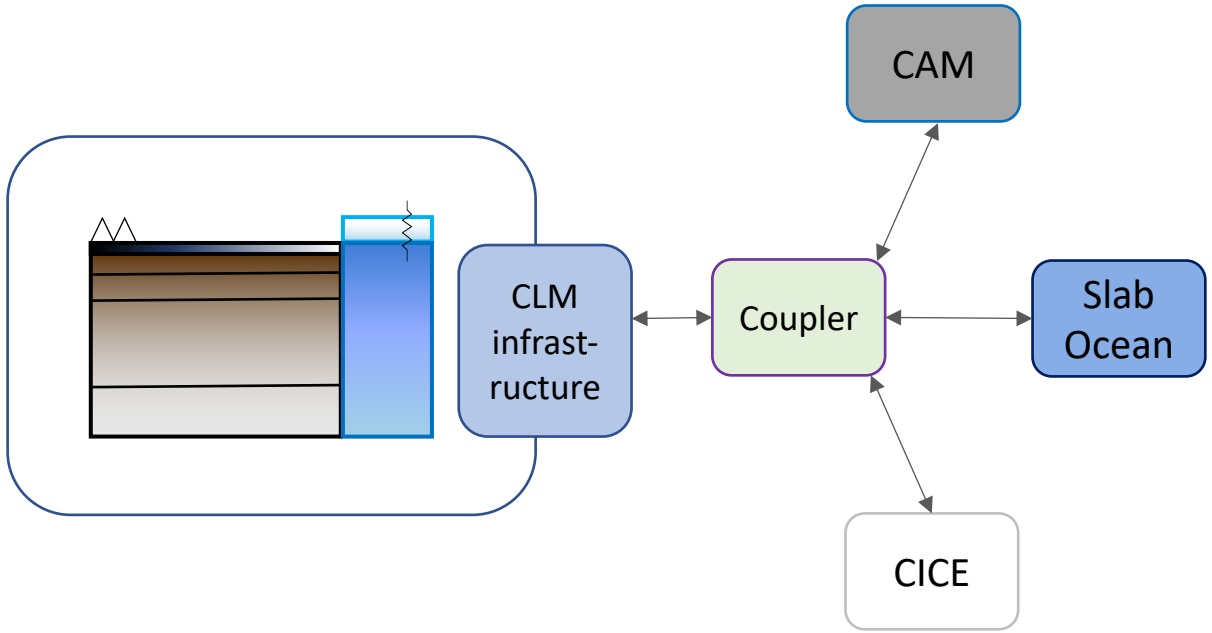
We would like to be able to **directly control** each of these surface properties



SLIM: what is in it?





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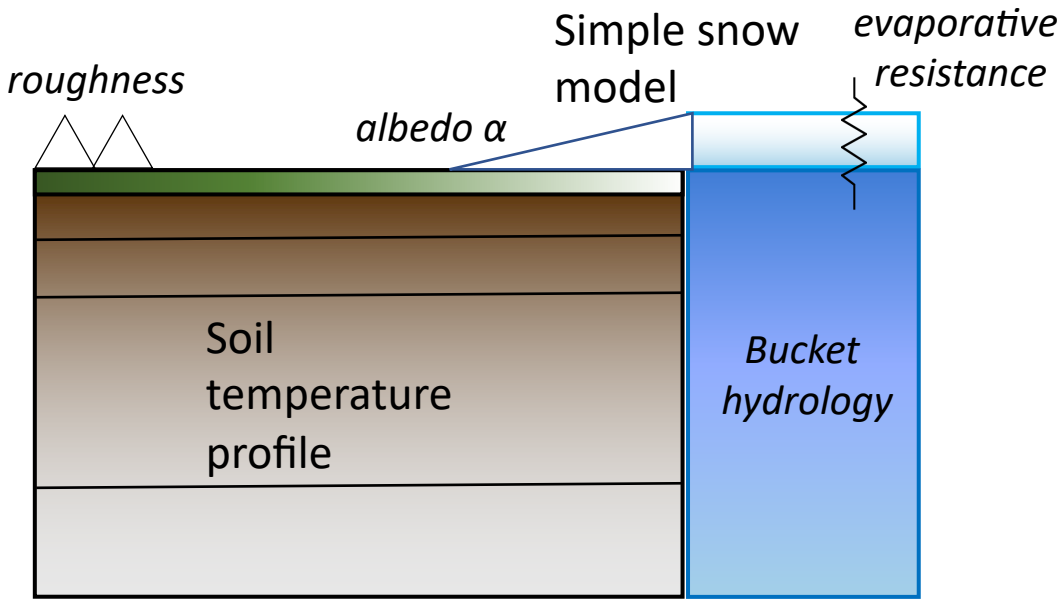

Tunable “knobs”:

- Albedo
- Roughness (vegetation height) [m]
- Evaporative resistance [s/m]
- Water bucket capacity [kg/m^2]
- Snow masking depth [kg/m^2]
- Soil heat capacity

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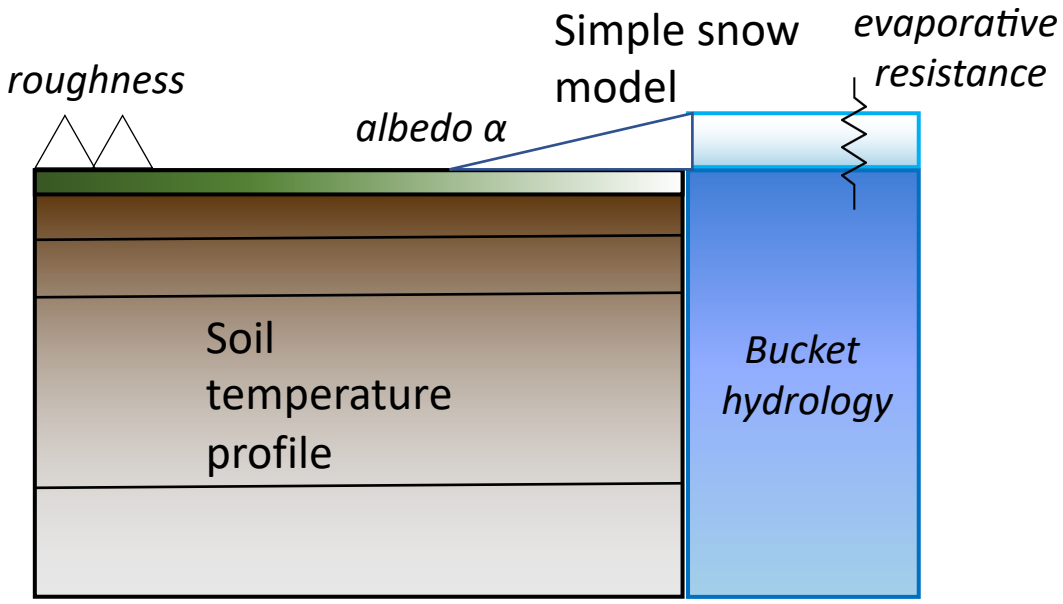

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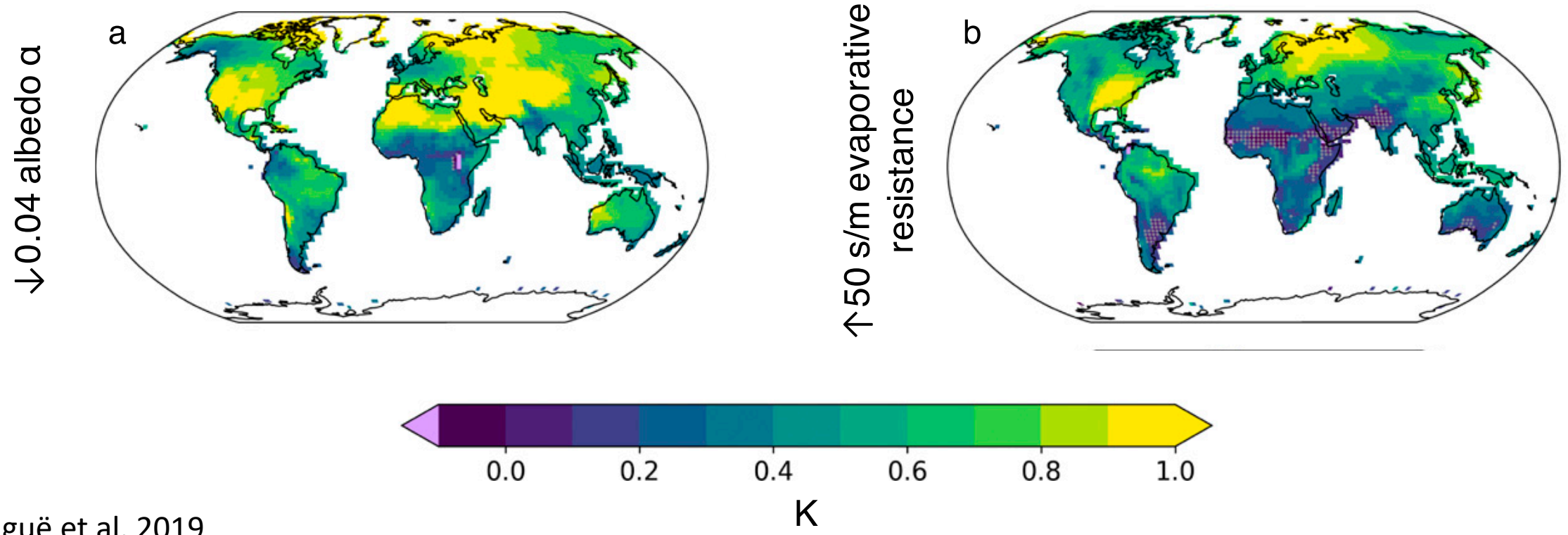
Directly controllable surface parameters → we know exactly what change is occurring on the land surface

Know the atmospheric response we observe is due to that imposed change

SLIM: Things we've used it for so far

Sensitivity tests: how the atmosphere responds to specific changes in the land surface

Δ Land Surface Temperature in a Coupled SLIM-CAM run

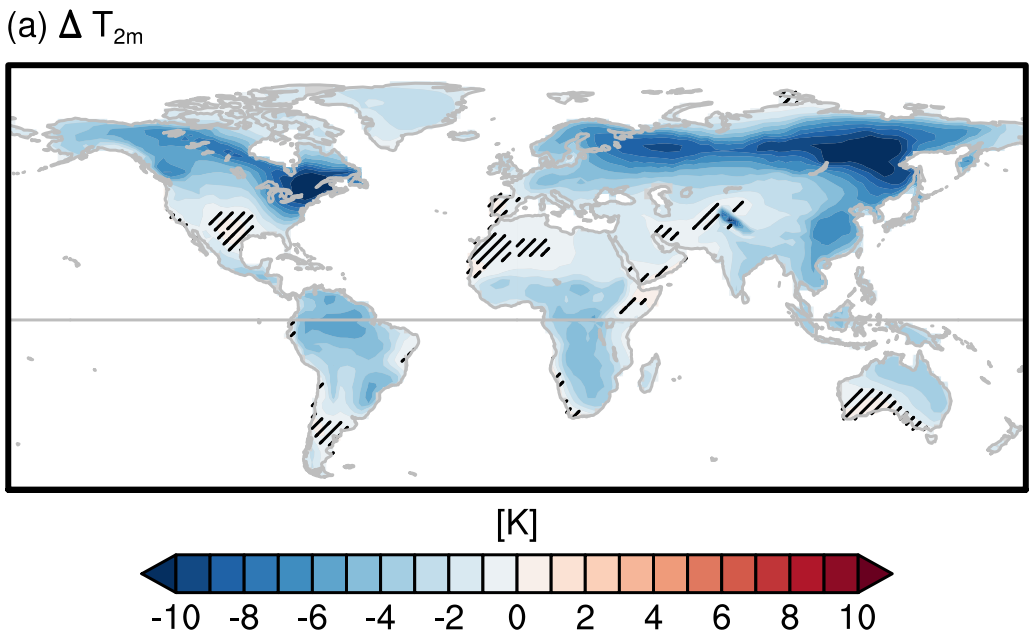


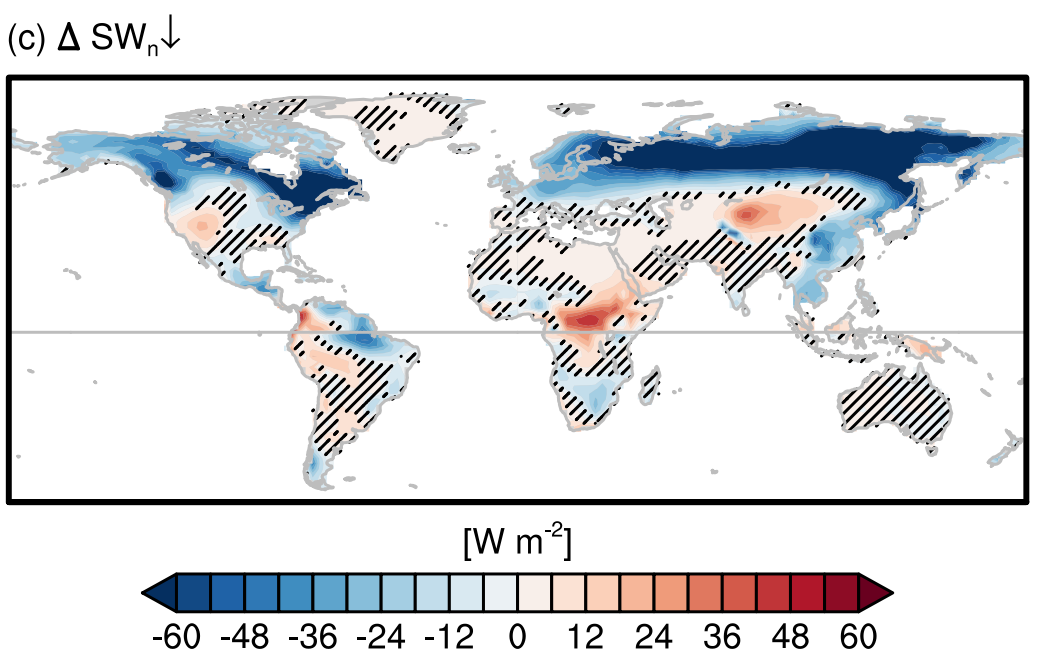
Laguë et al. 2019

SLIM: Things we've used it for so far

Evaporation impacts on temperature extremes & variability, and why

Low – High evaporative resistance





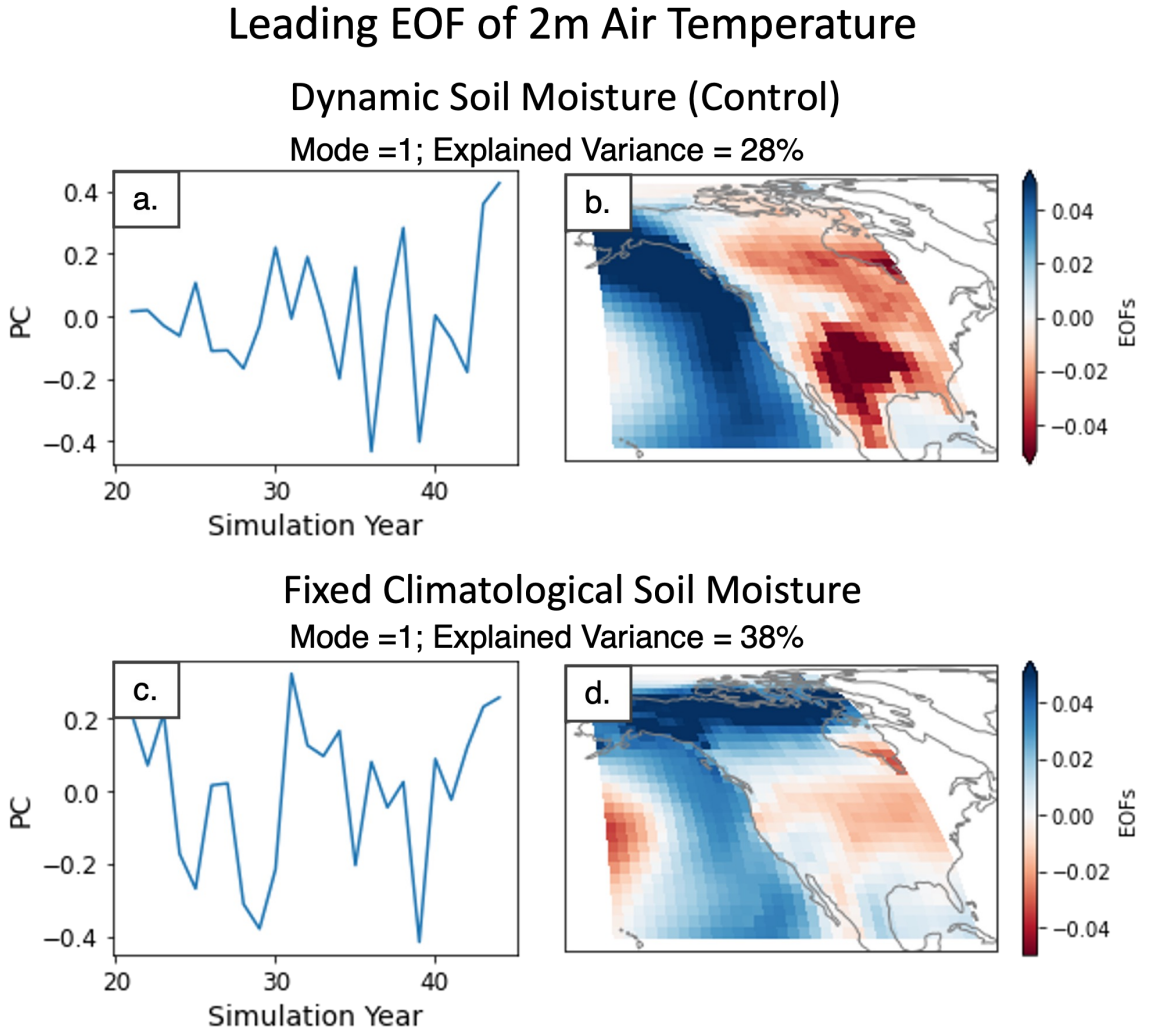
Kong et al. 2022

SLIM: Things we've used it for so far

Fixing climatological soil moisture (in this case, to look at temperature variability)

Freely interacting soil moisture

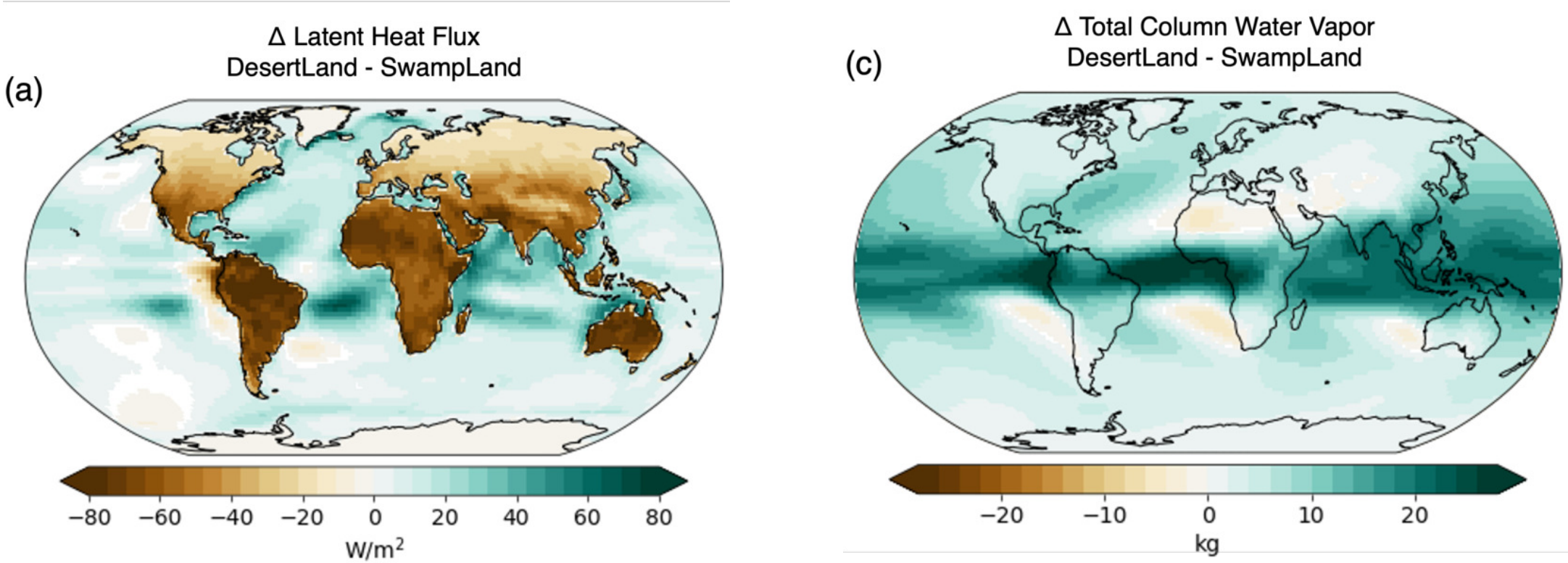
Prescribed climatolgoical soil moisture



Lague, Vargas Zepettello et al. in Prep

SLIM: Things we've used it for so far

Crazier thought experiments, like comparing a Desert World to a Swamp World



(Desert evaporates less, but ends up with more water vapour globally; residence time of water vapour goes up ~50%)

Lague et al. In Review

SLIM: feedback we'd like from AWMG

- Some things CAM needs from the land that SLIM can't produce:
  - Dust (we use a climatological dust flux from CLM) ✓
  - Dry deposition of aerosols ?
  - Anything glaring here we've missed? ?

SLIM: coming to a CESM repo near you…

- SLIM will be included in the CESM 2.3 release
  (thanks to much effort from Erik Kluzek and Sam Levis!)
  - Be able to toggle on/off in the land model spot of the namelist

    2000_CAM60_**CLM50%SP**_CICE%PRES_DOCN%DOM_MOSART_CISM2%NOEVOLVE_SWAV

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Questions/comments/concerns?

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