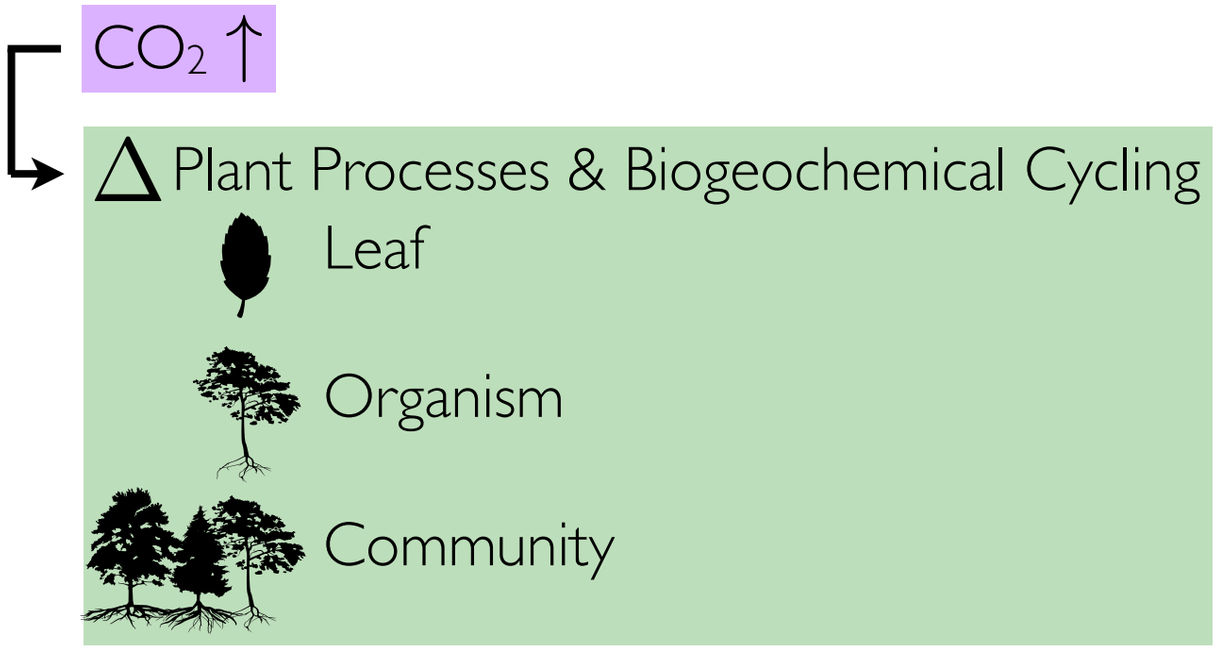
EVALUATING THE INFLUENCE OF PLANT-CLIMATE INTERACTIONS AND FEEDBACKS ON HYDROLOGIC CYCLING (Tree2H_2O)

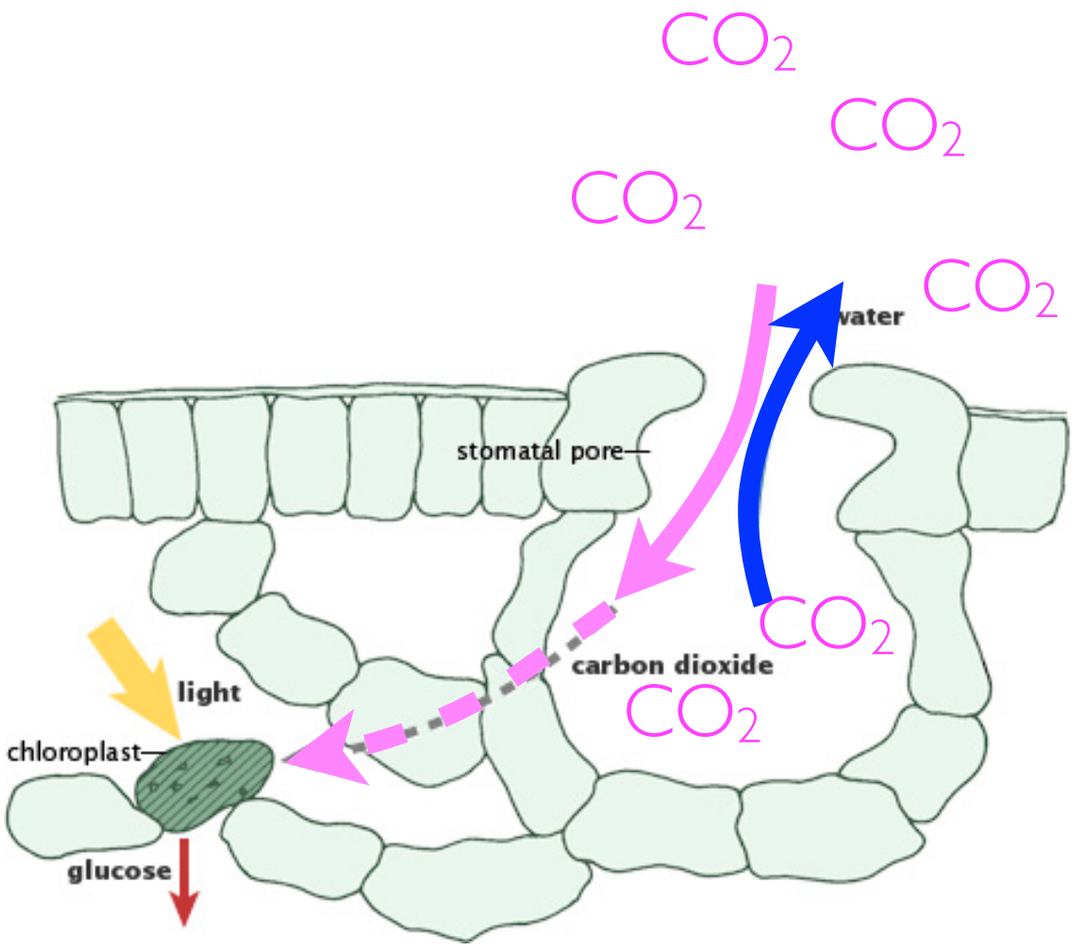
Abigail Swann, *University of Washington*
Christopher Still, *Oregon State University*
Gabriel Kooperman, *University of Georgia*
Charlie Koven, *Lawrence Berkeley National Laboratory*
Forrest Hoffman, *Oak Ridge National Laboratory*
Jim Randerson, *University of California, Irvine*

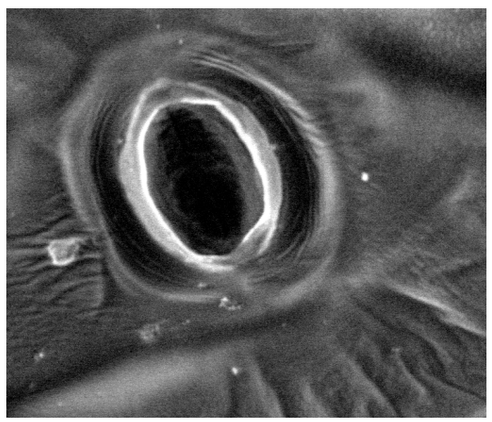
⇧CO_2 increases temperature

⇧CO_2 alters plant processes and biogeochemical cycling



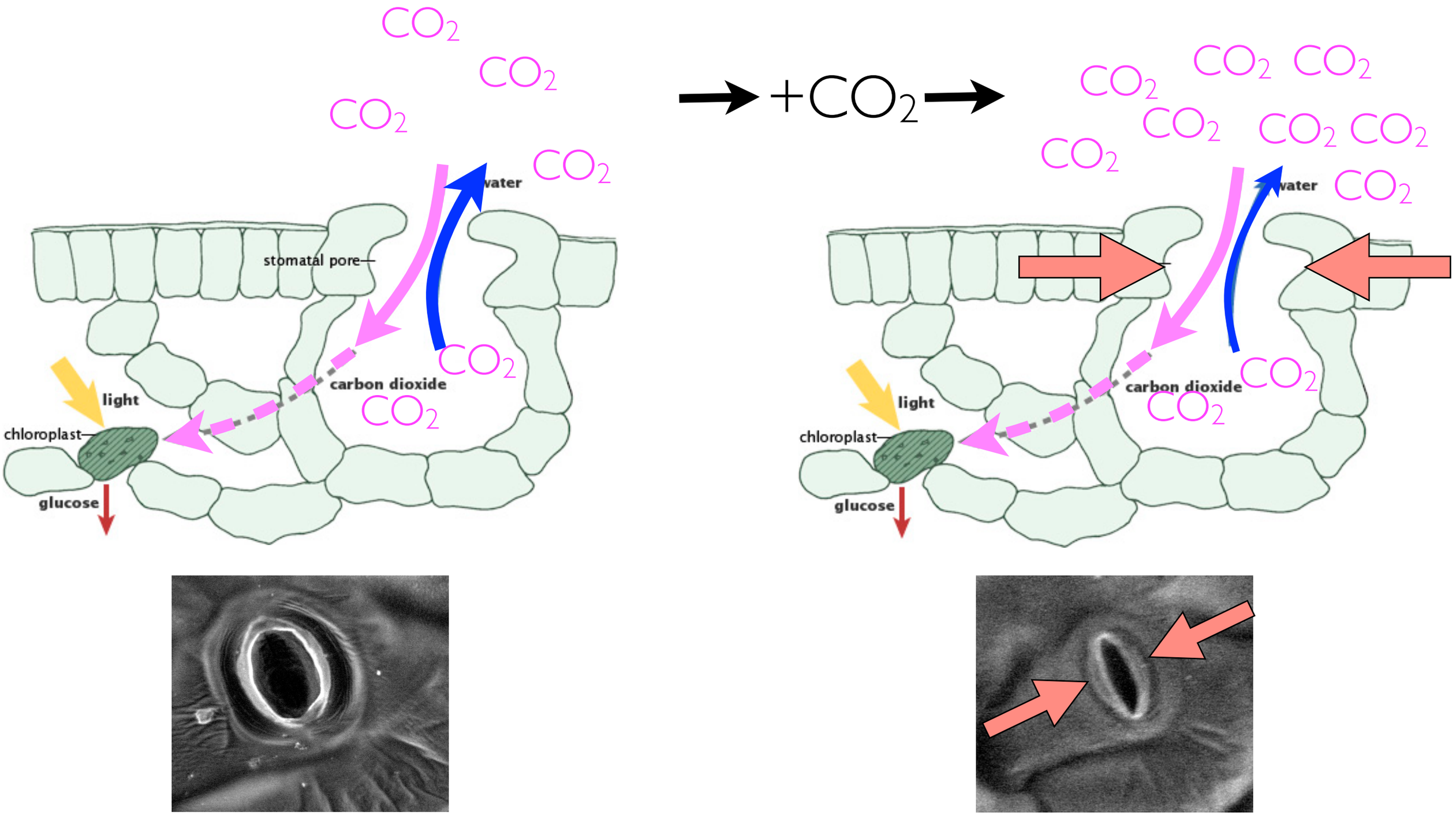
Stomata regulate the flux of water and carbon





adapted from Sellers 1992

Stomatal opening depends on CO_2



adapted from Sellers 1992

⇧CO_2 alters plant processes and biogeochemical cycling

CO_2 ↑

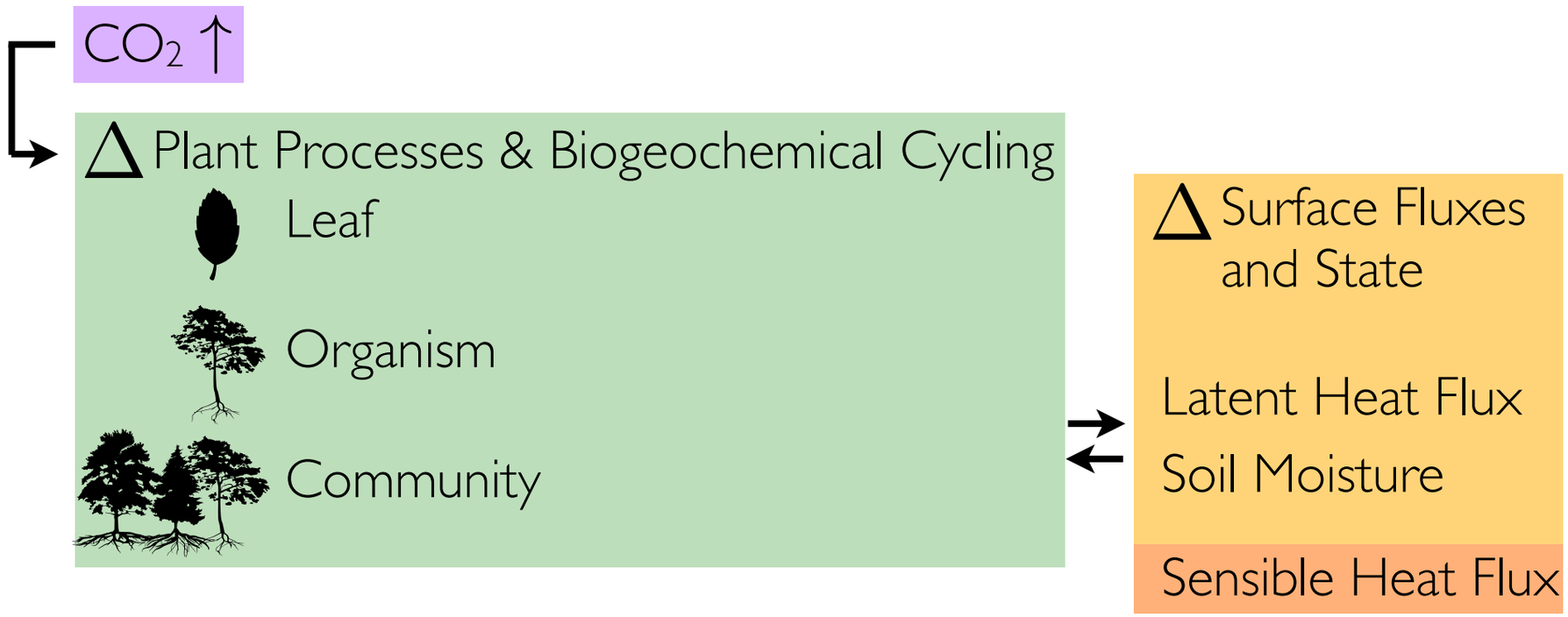
Δ Plant Processes & Biogeochemical Cycling

Leaf
(stomatal conductance, photosynthesis)

Organism
(leaf area, hydraulics)

Community
(composition)

ΔPlant functioning alters Surface Fluxes



ΔPlant functioning alters Surface Fluxes

CO_2 ↑

Δ Plant Processes & Biogeochemical Cycling

Leaf

Organism

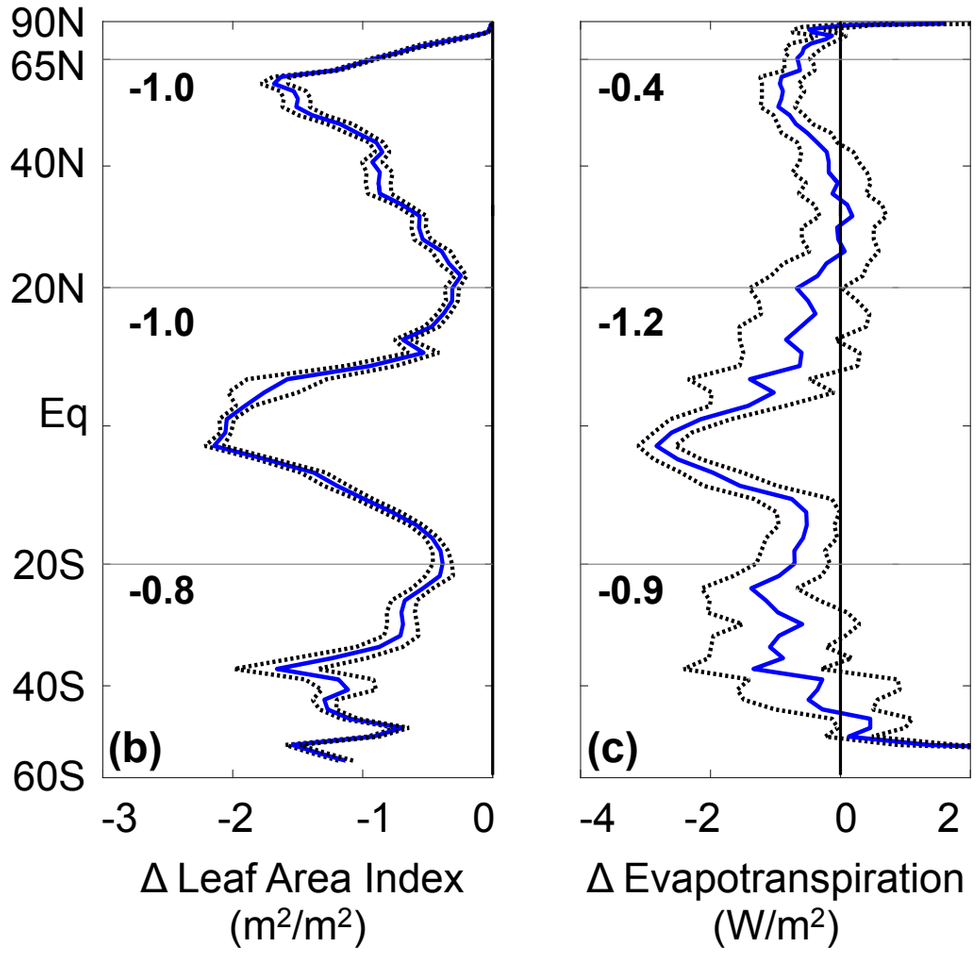
Community

Δ Surface Fluxes and State

Latent Heat Flux

Soil Moisture

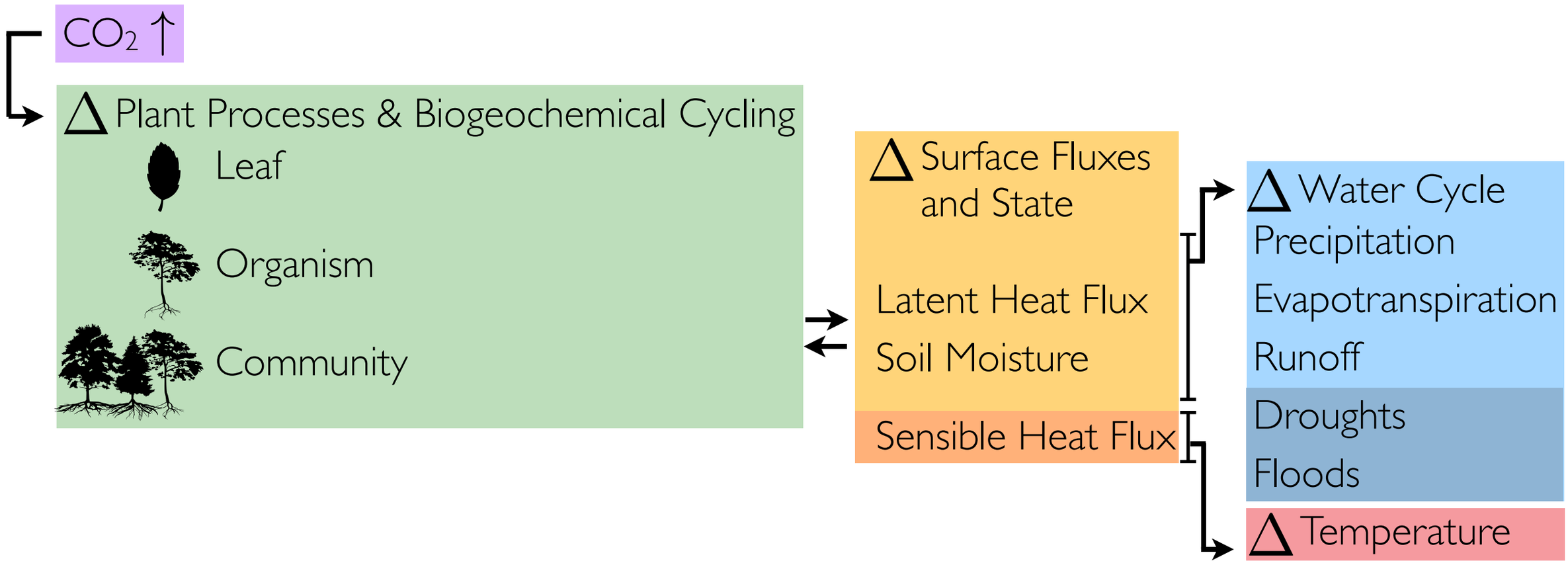
Sensible Heat Flux



ΔLeaf Area and ΔEvapotranspiration due to thicker leaves (higher LMA)

Kovenock and Swann 2018
Global Biogeochem. Cycles

ΔFluxes alters water cycle & precipitation



ΔFluxes alters water cycle & precipitation

$CO_2 \uparrow$

Δ Plant Processes & Biogeochemical Cycling

- Leaf
- Organism
- Community

Δ Surface Fluxes and State

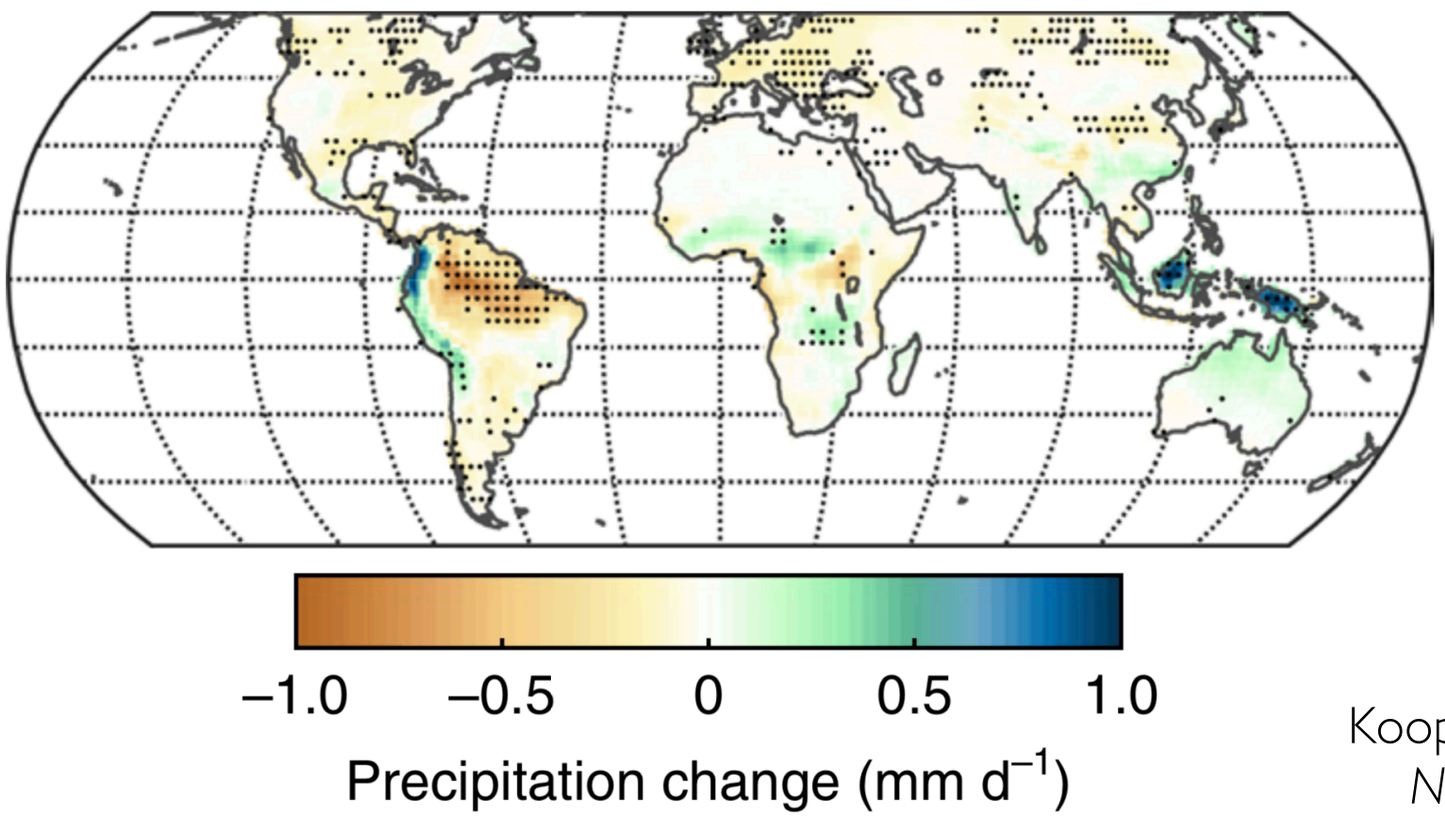
- Latent Heat Flux
- Soil Moisture
- Sensible Heat Flux

Δ Water Cycle

- Precipitation
- Evapotranspiration
- Runoff
- Droughts
- Floods

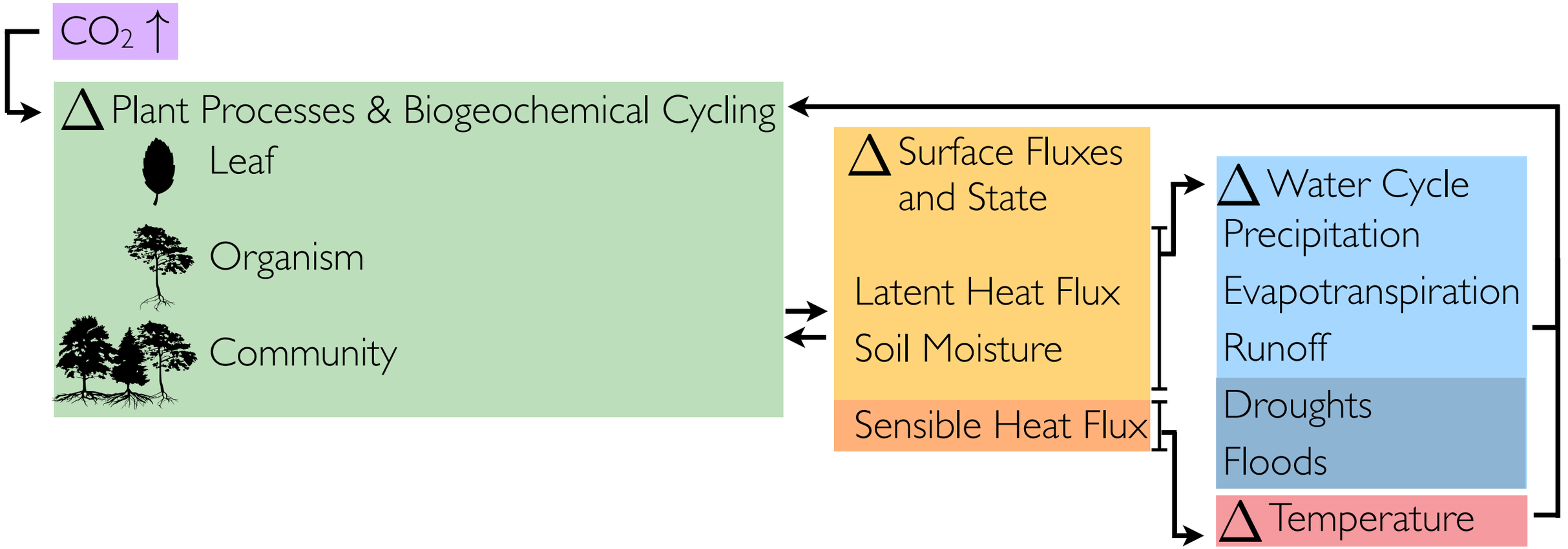
Δ Temperature

ΔRainfall from 4xCO_2 due to Physiology only

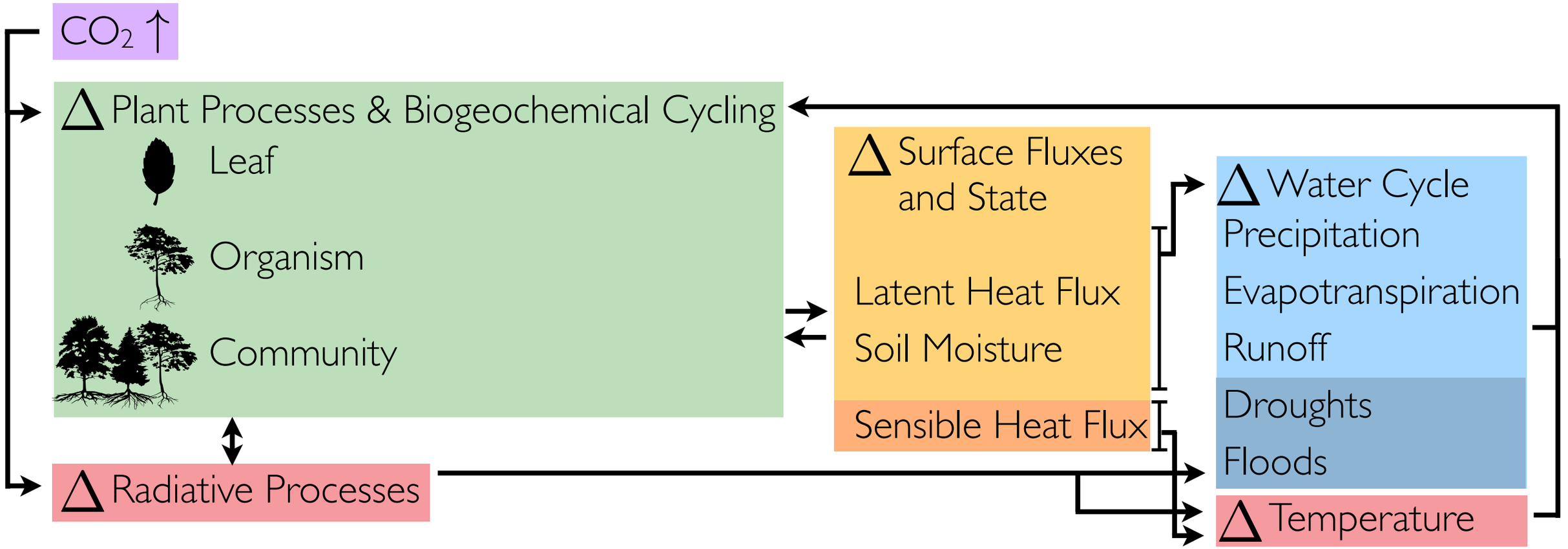


Kooperman et al. 2018
Nat. Clim. Change

Feedbacks to plants & biogeochemical cycling



How do plant-driven reponses compare to radiative processes?



Leaf, Organism, Community => Hydrological Cycling

	Scientific Focus
Obj. 1	Physiological vs. Radiative
Obj. 2	 stomatal conductance & photosynthesis
Obj. 3	 leaf area, hydraulics
Obj. 4	 ecosystem composition

Physiological vs. Radiative

Leaf Level

Organism Level

Community Level

Δ Water Cycle
- Precipitation
- Evapotranspiration
- Runoff
- Droughts
- Floods

Multiple modeling tools + observational benchmarks

CMIP6

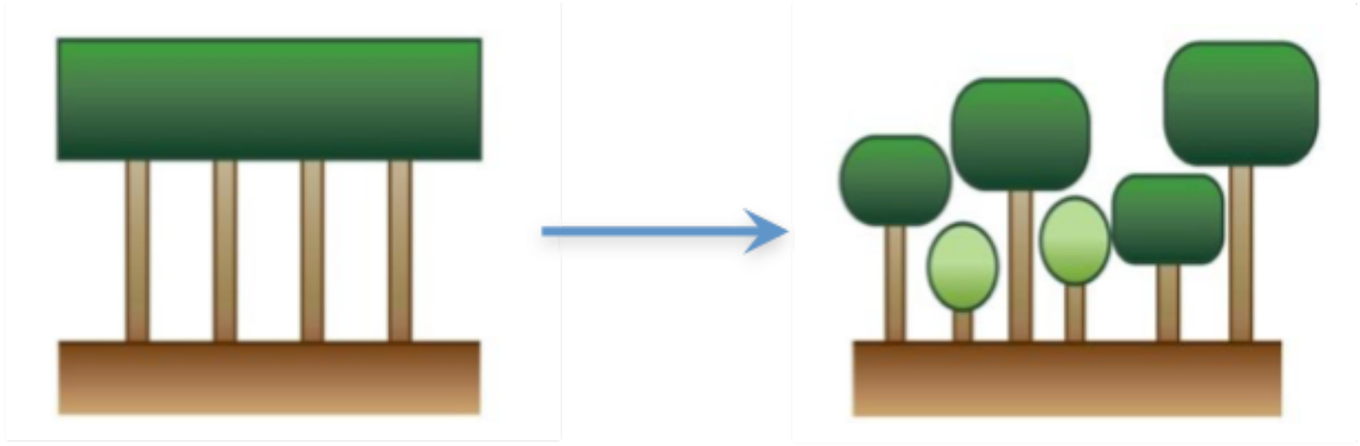
Compare many
Earth System Models

E3SM

Standard E3SM

E3SM-FATES

Sensitivity simulations



Benchmarks:
$\delta^{13}C$ from tree rings &
eddy covariance fluxes to
constrain water/carbon
fluxes, water use effeciency

Project Components

	Scientific Focus	Tasks		
Obj. 1	Physiological vs. Radiative	Coupled Model Context (C4MIP)	Test w/tree ring isotopes and growth	
Obj. 2	 stomatal conductance & photosynthesis	weak vs. strong slope of Medlyn model (E3SM)	Test w/ isotope derived iWUE	
Obj. 3	 leaf area, hydraulics	dynamic vs. fixed leaf area w/ conductance coupling (E3SM)	coupling between hydraulics and conductance (E3SM)	Test w/isotope derived Ci/Ca
Obj. 4	 ecosystem composition	dynamic vs. fixed composition (FATES)		

Tools
- CMIP6
- ^{13}C test
- E3SM
- FATES

Tree2H_2O

	Scientific Focus
Obj. 1	Physiological vs. Radiative
Obj. 2	stomatal conductance & photosynthesis
Obj. 3	leaf area, hydraulics
Obj. 4	ecosystem composition

Physiological vs. Radiative

Leaf Level

Organism Level

Community Level

→ Δ Water Cycle
Precipitation
Evapotranspiration
Runoff
Droughts
Floods

Leaf, Organism, Community => Hydrological Cycling