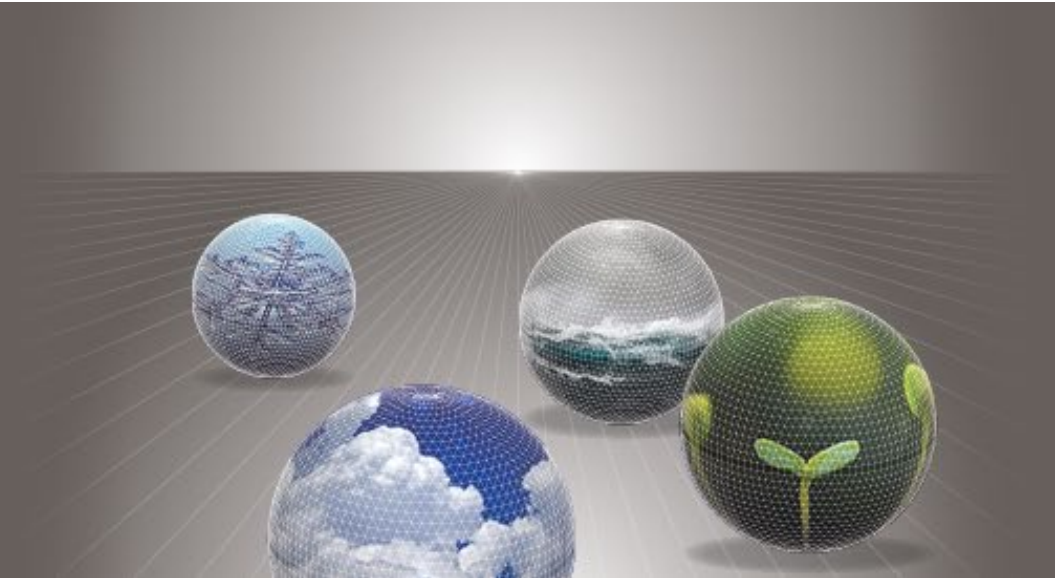


Vegetation controls on land-atmosphere interactions



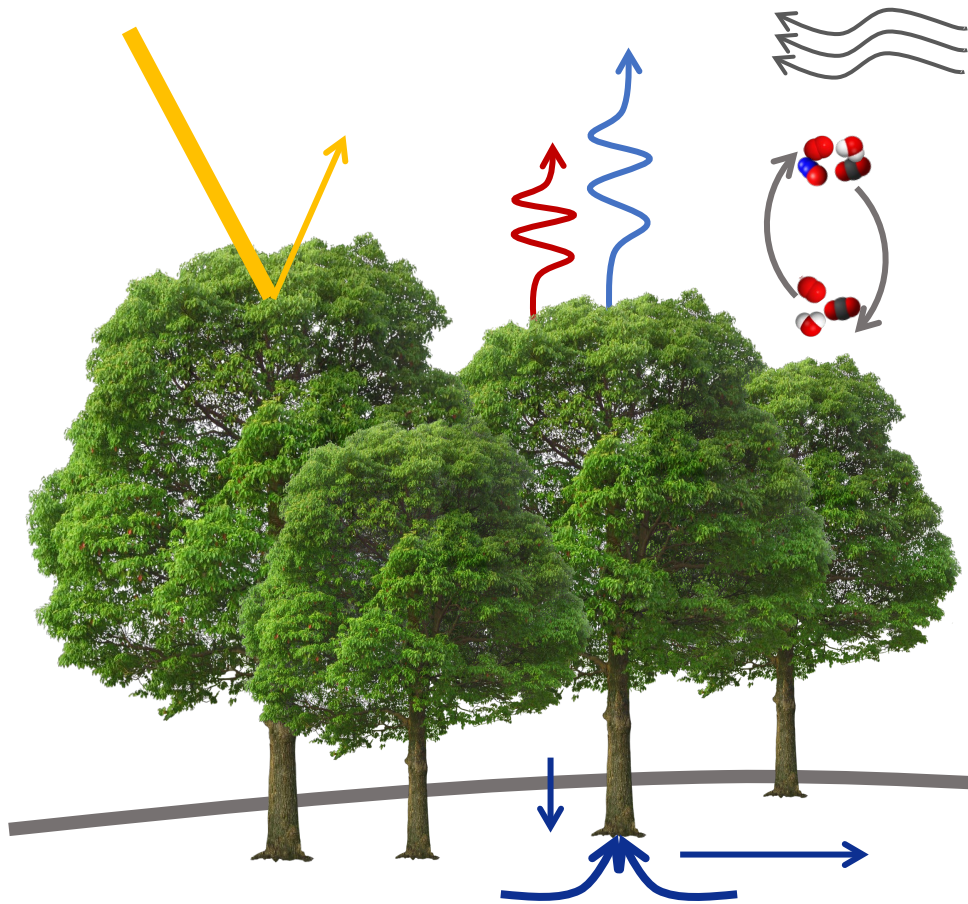
Ana Bastos

Max Planck Institute for Biogeochemistry, Jena, DE

ECMWF Annual Seminar 2022 | Challenging physics in seamless predictions

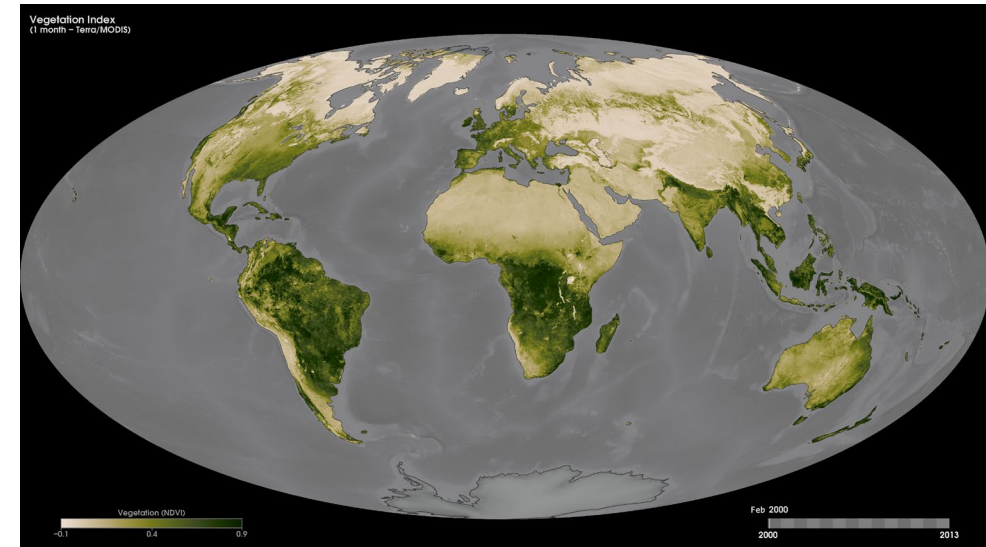
Vegetation and the land surface

>70% of the land surface is covered by vegetation

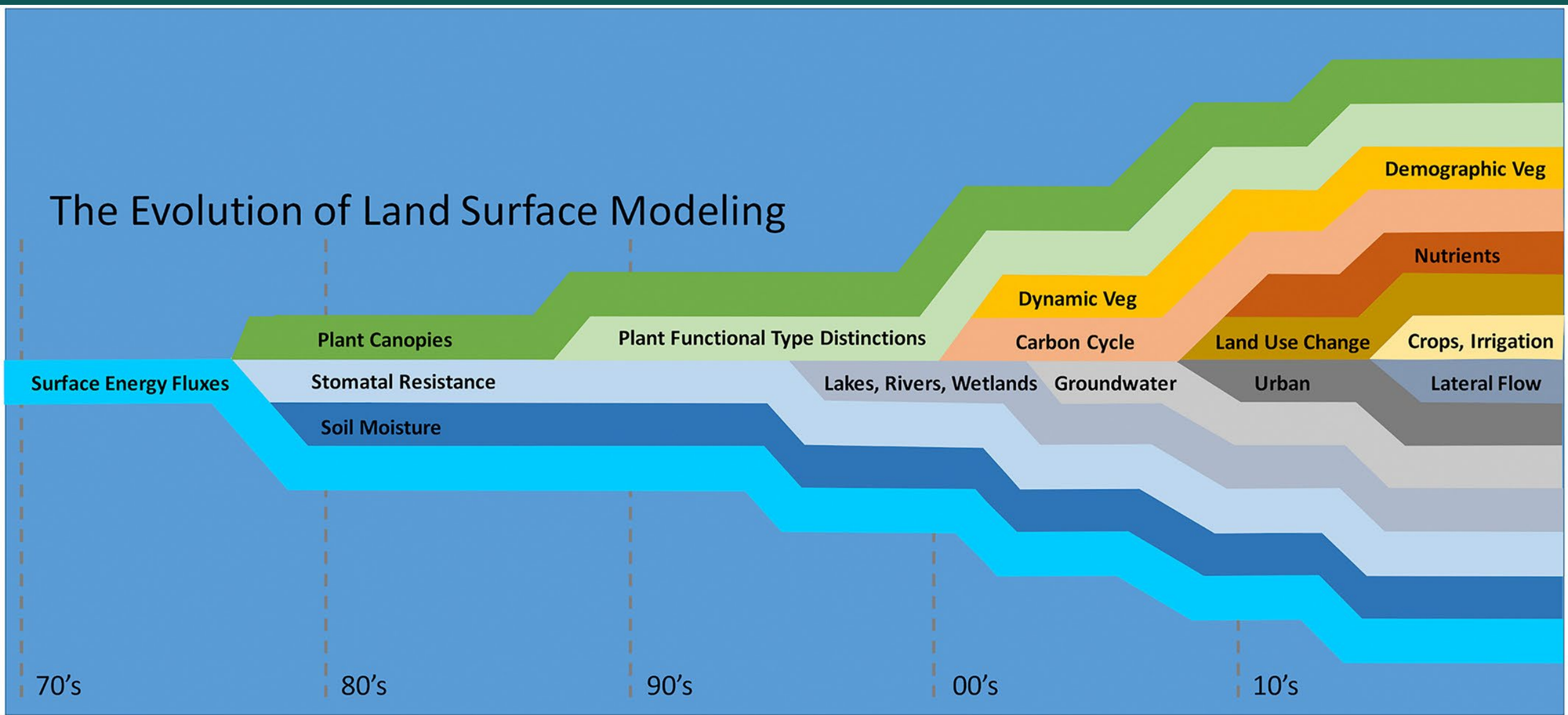


Albedo
Sensible heat
Latent heat
Wind speed
Trace gases
Water balance

Source: NASA Earth Observatory

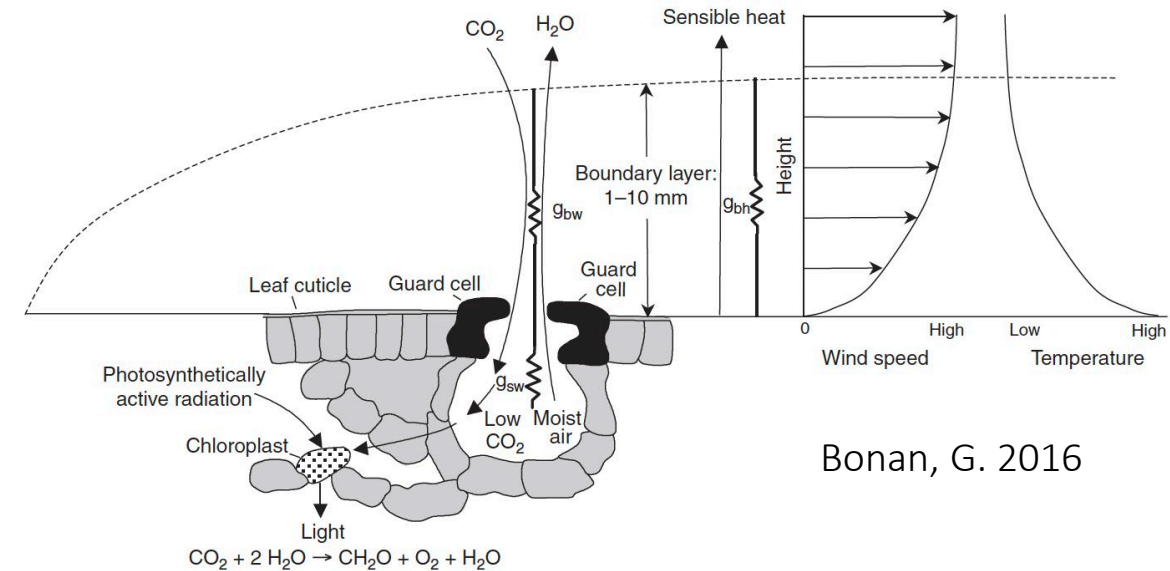
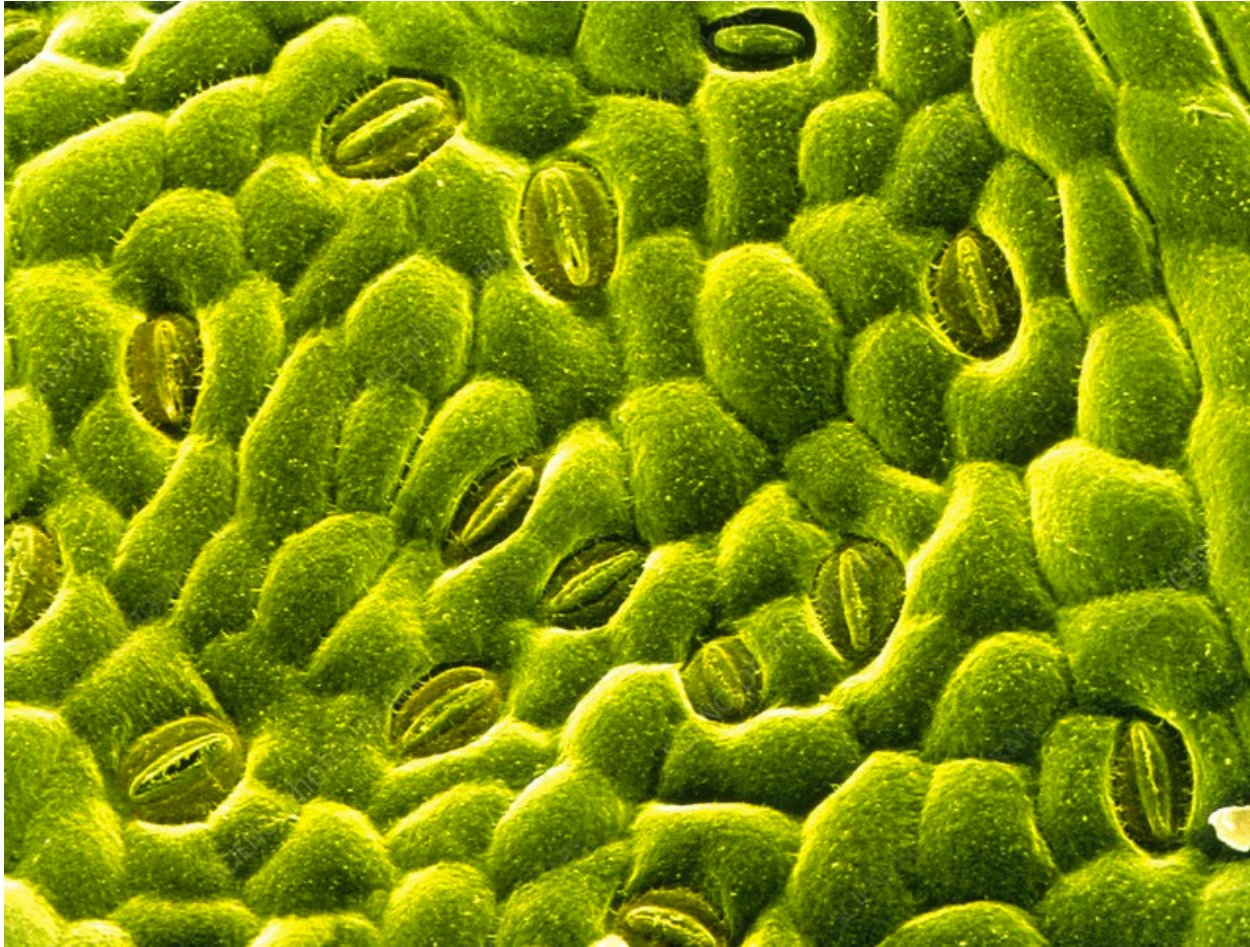


The Evolution of Land Surface Modeling



Energy, water and biogeochemistry coupling

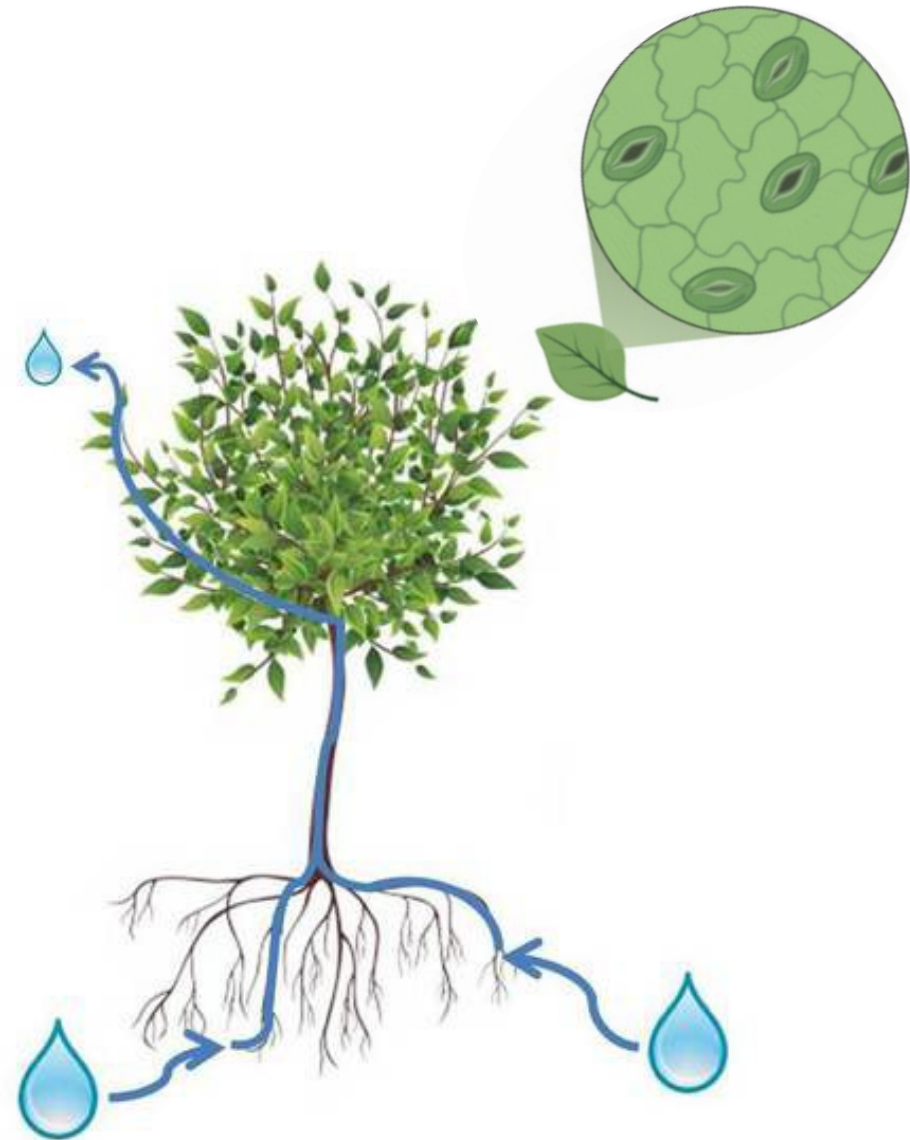
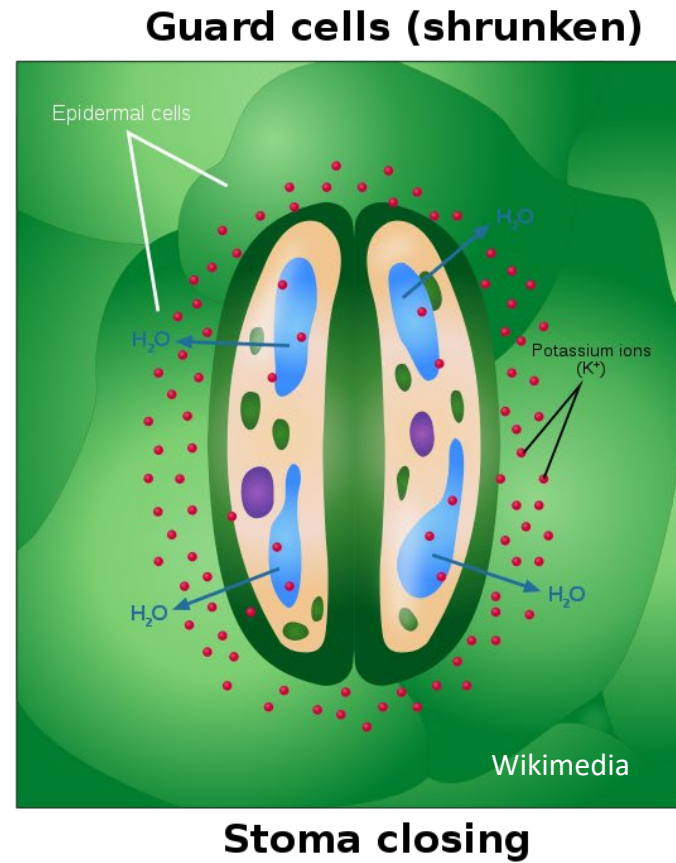
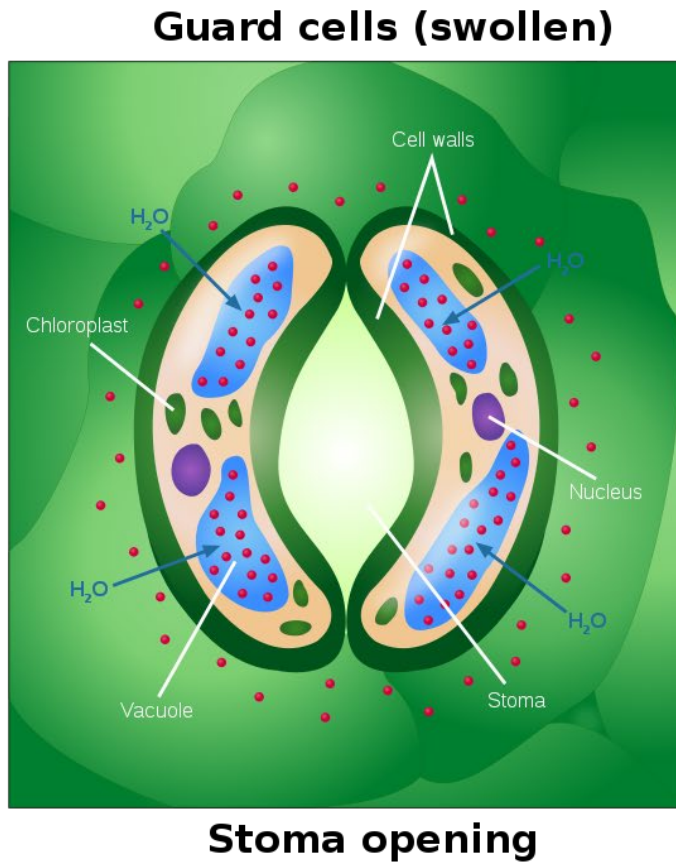
Stomata regulate water, energy and carbon exchange and influence micrometeorology at the leaf level



These processes are then scaled up to ecosystem level, influenced by leaf area and canopy structure

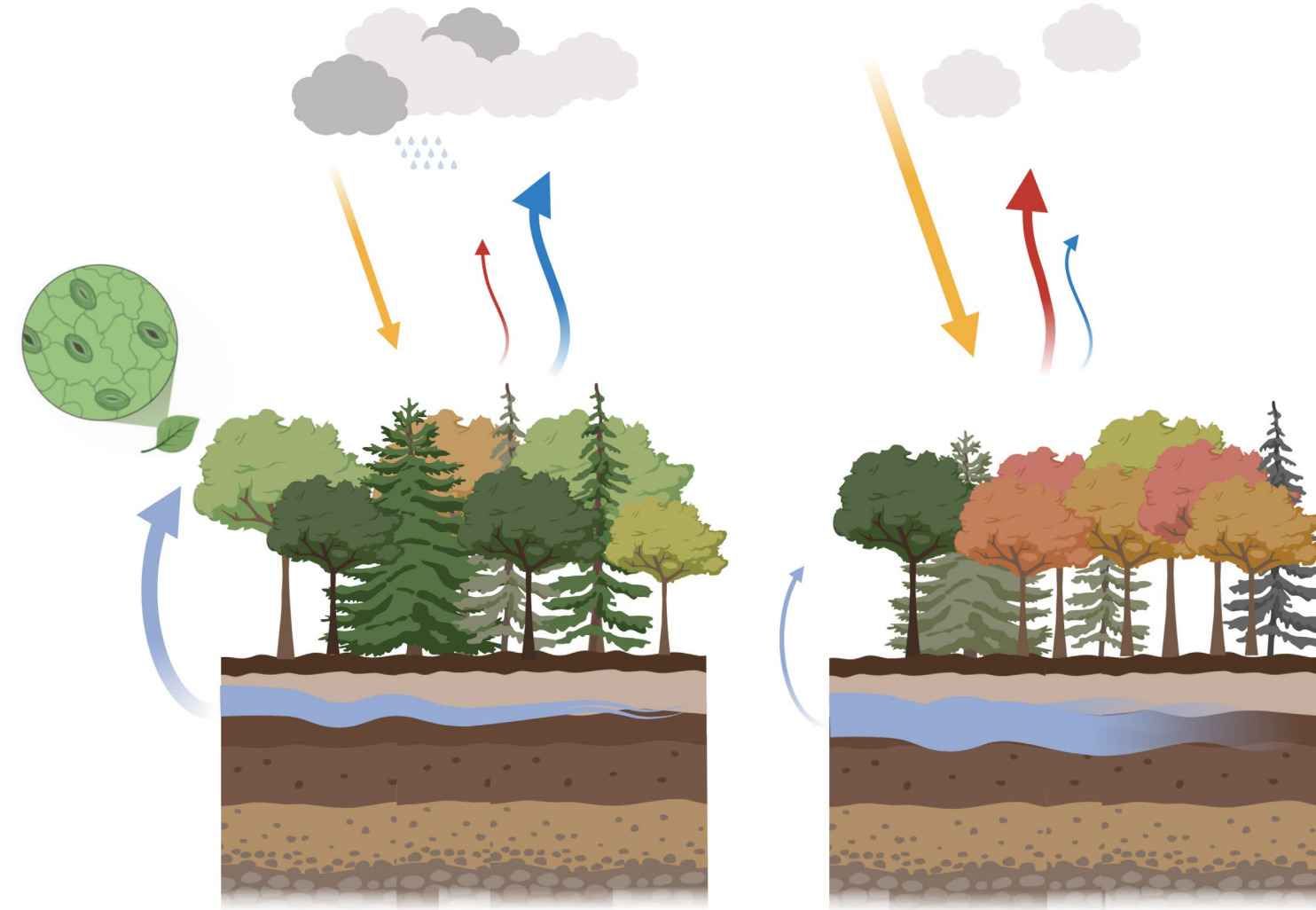
Energy, water and biogeochemistry coupling

Stomatal aperture regulates water exchange



Energy, water and biogeochemistry coupling

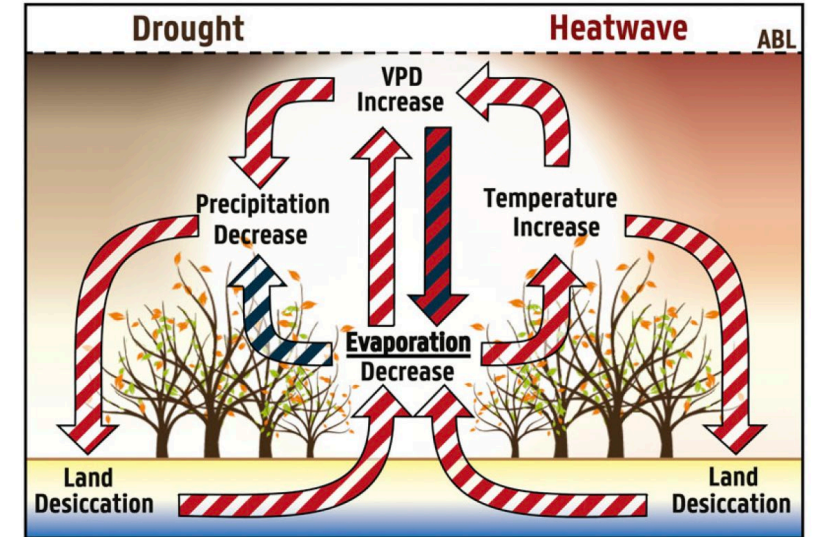
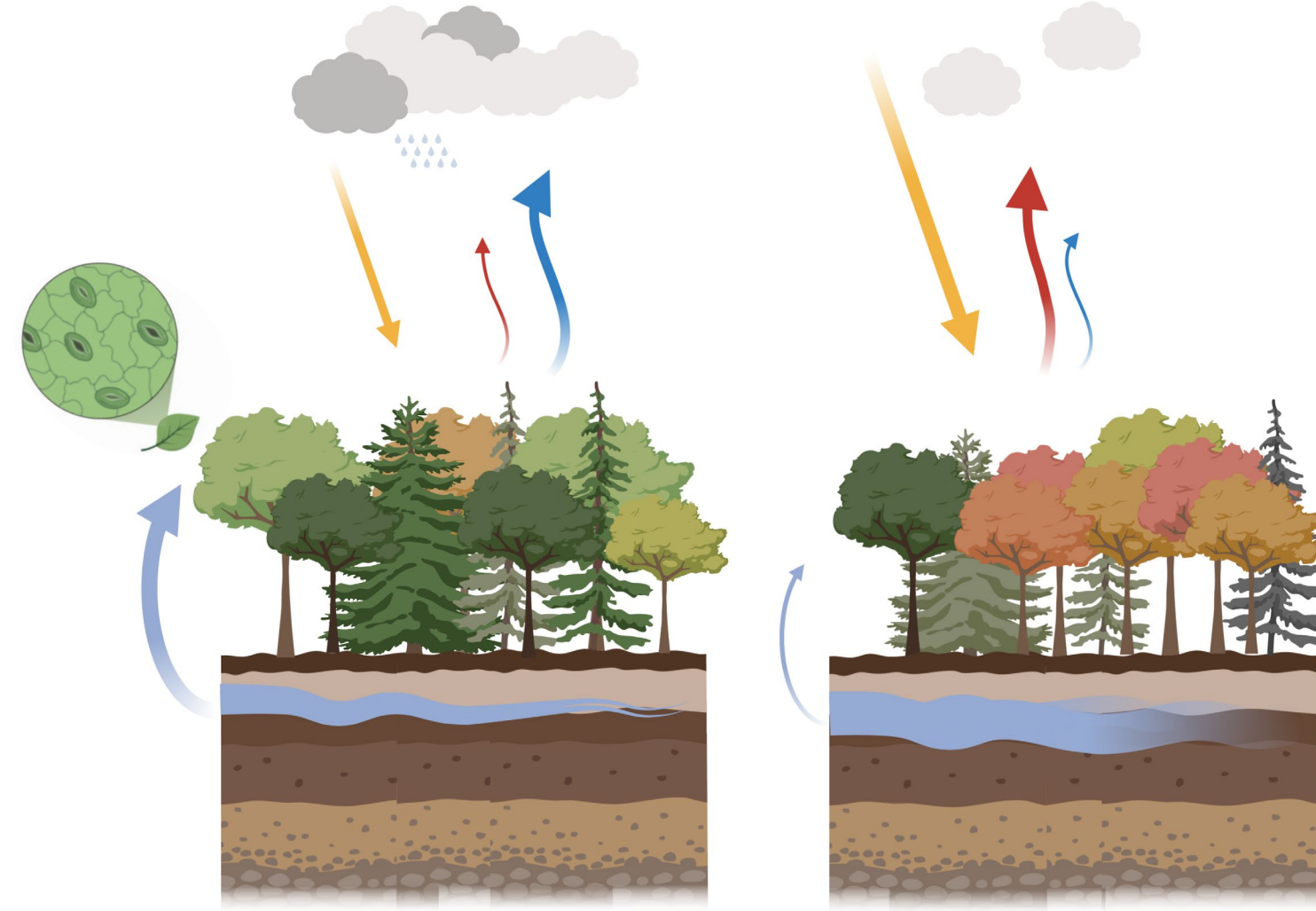
... but also soil-moisture, energy exchanges & atmospheric properties



Stomatal responses to environmental conditions contribute to land-atmosphere feedbacks

Energy, water and biogeochemistry coupling

... but also soil-moisture, energy exchanges & atmospheric properties



Especially relevant during water limited conditions!

Miralles et al. ANYAS(2019)

Vegetation & land-atmosphere interactions

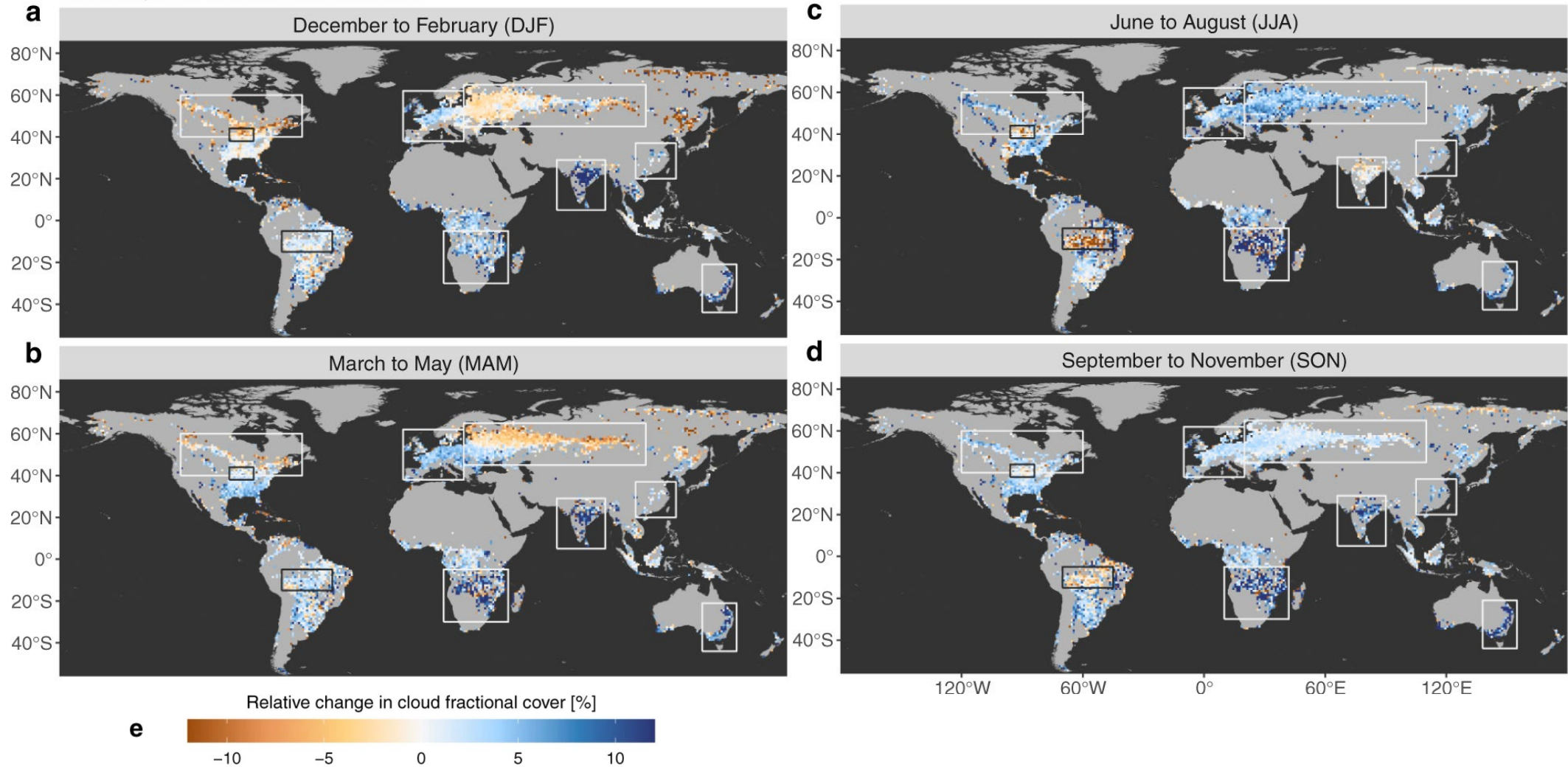
- Forest cover changes and cloud patterns
- Influence of vegetation in skill of S2S forecast of 2m T
- Vegetation modulation of water/energy exchanges during droughts
- Vegetation modulation of drought intensity

Vegetation & land-atmosphere interactions

- Forest cover changes and cloud patterns
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Potential of afforestation to increase low level cloud cover

Seasonal patterns of relative change
Resulting from potential afforestation



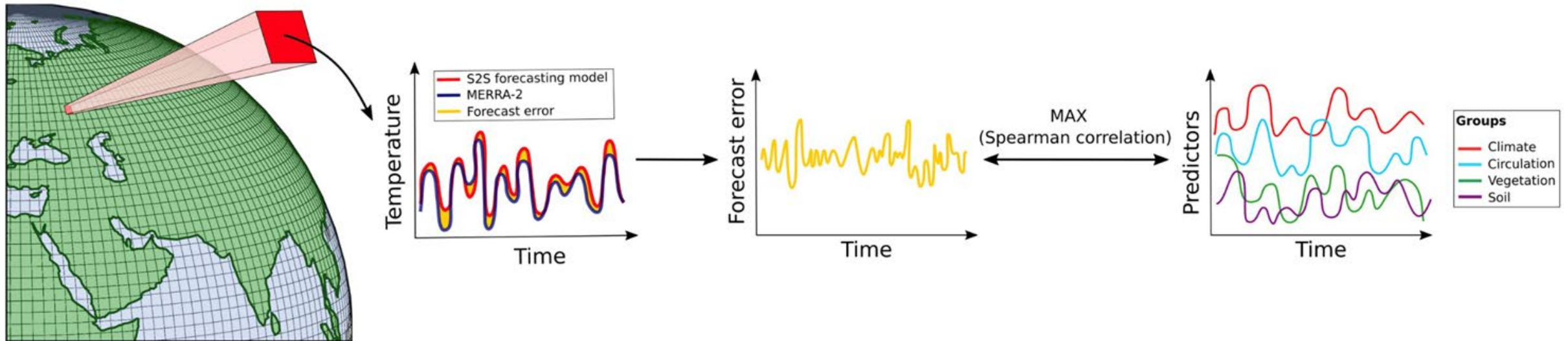
Vegetation & land-atmosphere interactions

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Diagnosing S2S forecast errors in 2m temperature



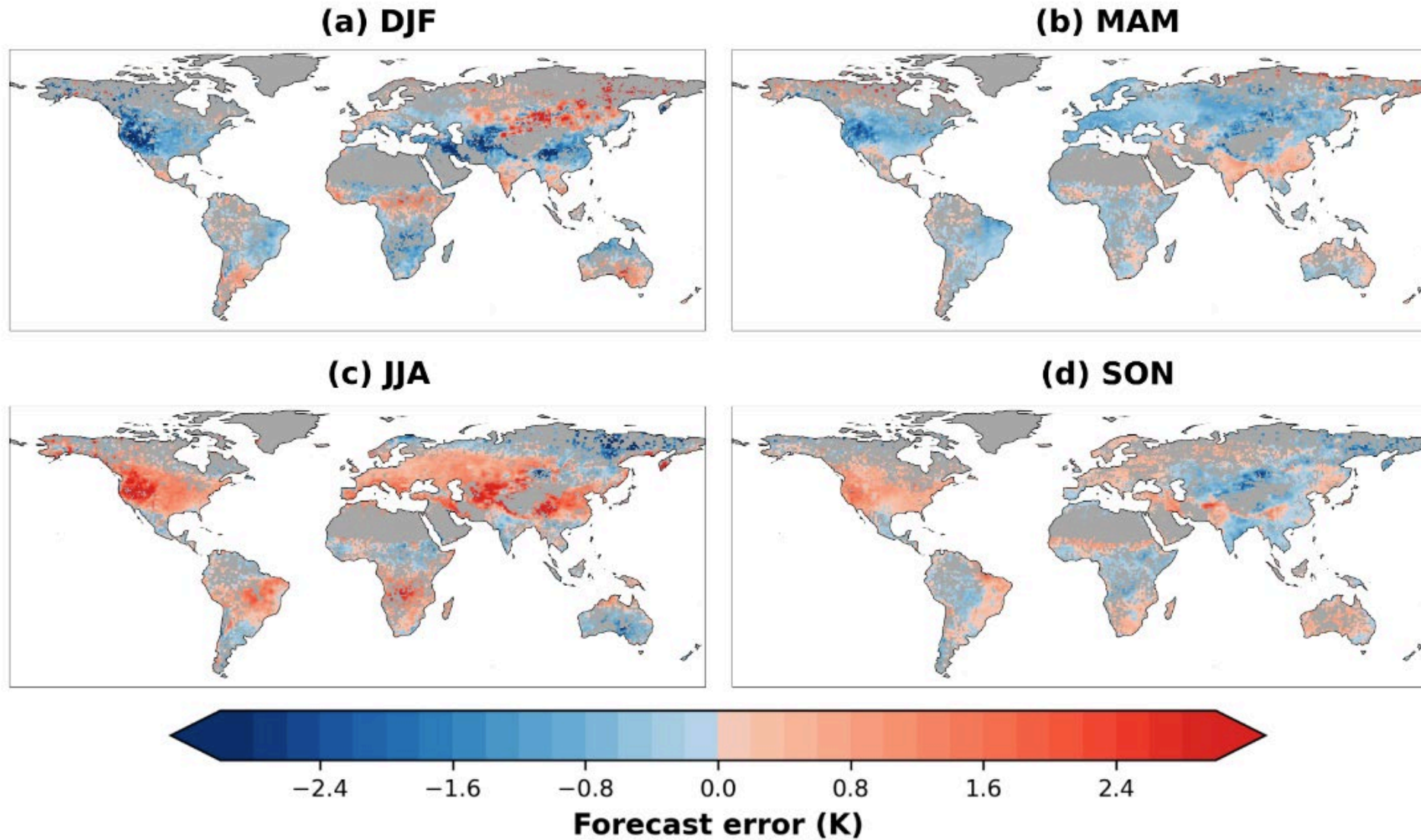
Melissa Ruiz



Strong seasonality in sign of S2S forecast errors



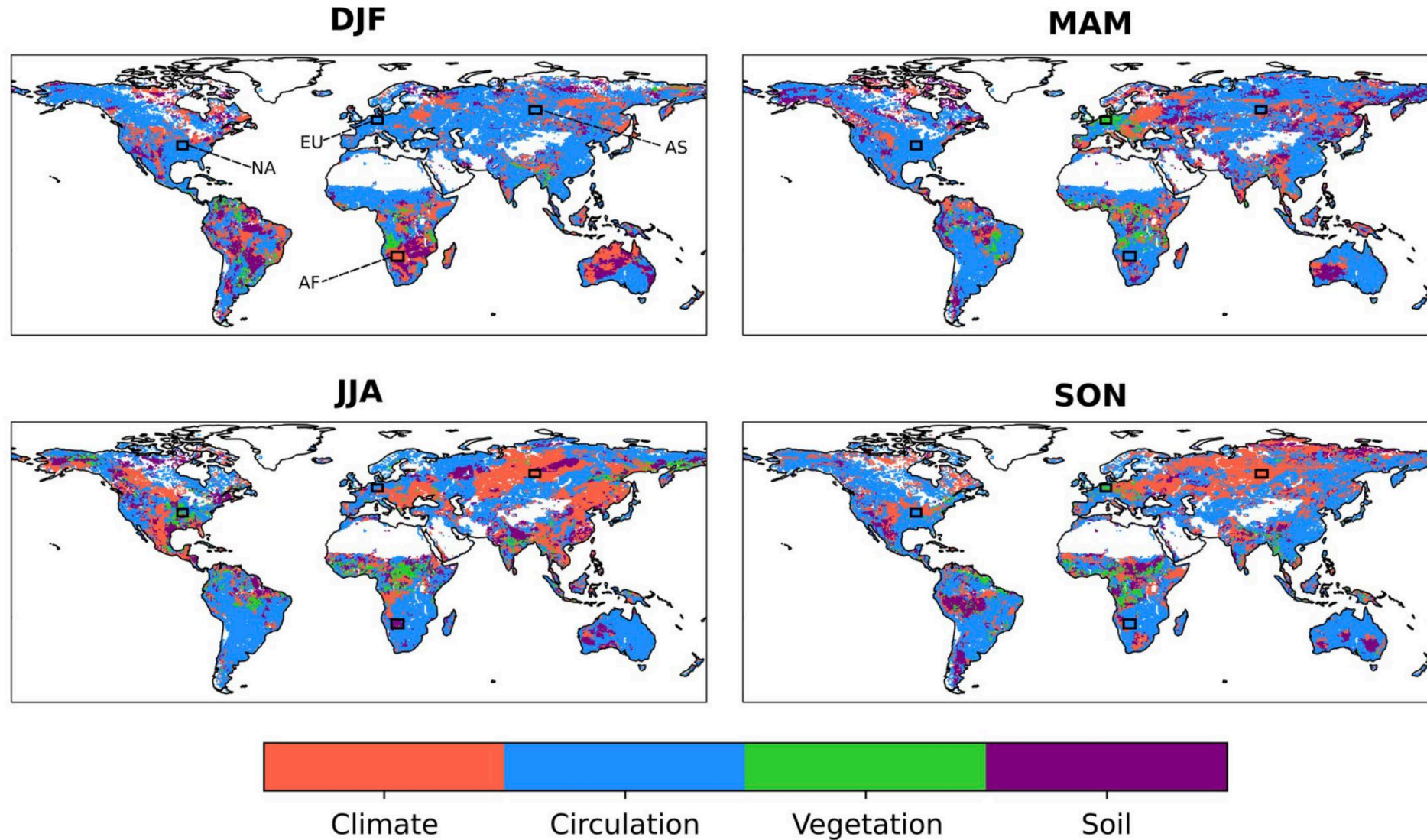
Melissa Ruiz



Strong seasonality in sign of S2S forecast errors



Melissa Ruiz

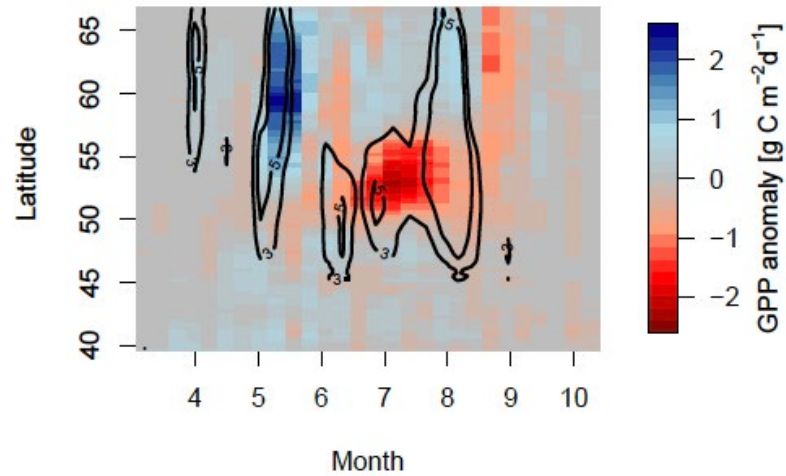


Vegetation & land-atmosphere interactions

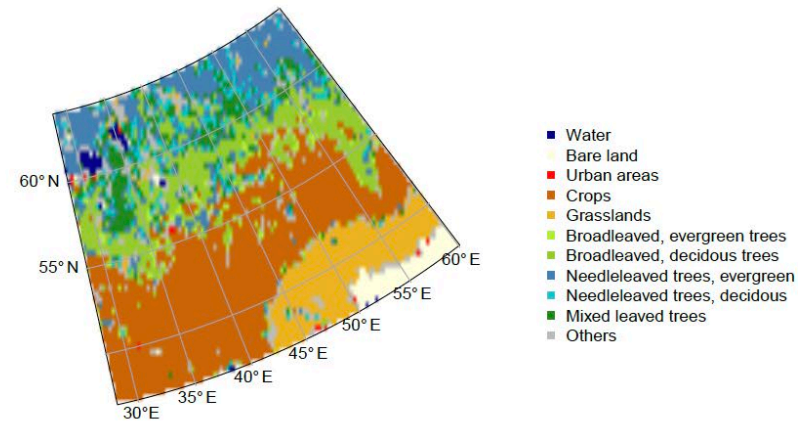
- Forest cover changes and cloud patterns
- Influence of vegetation in skill of S2S forecast of 2m T
- **Vegetation modulation of water/energy exchanges during droughts**
- Vegetation modulation of drought intensity

Modulation of evaporative fraction during heat/drought

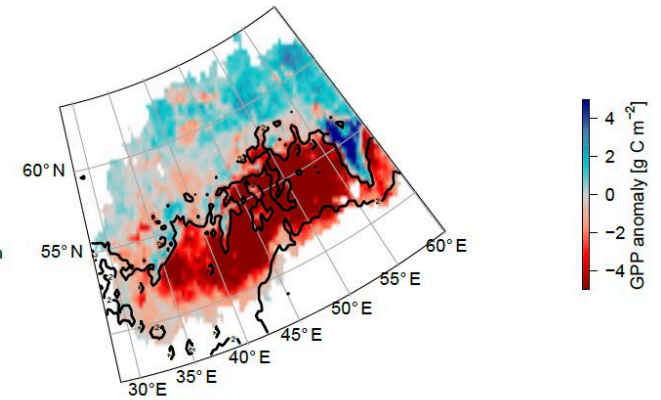
Land-cover modulation of impacts of the 2010 heatwave on gross primary productivity and water-use efficiency



(a) Land cover

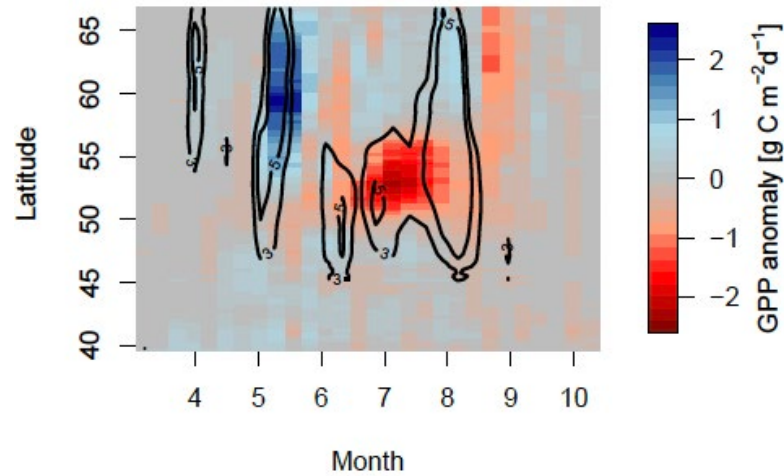


(b) Sum of GPP during the hydrometeorological summer event

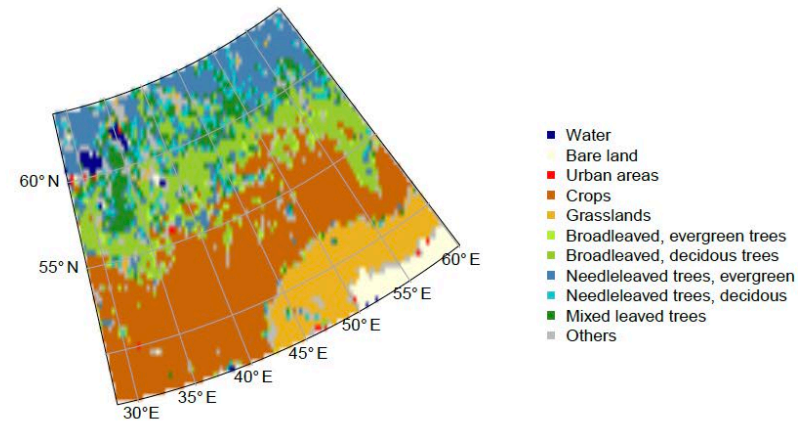


Modulation of evaporative fraction during heat/drought

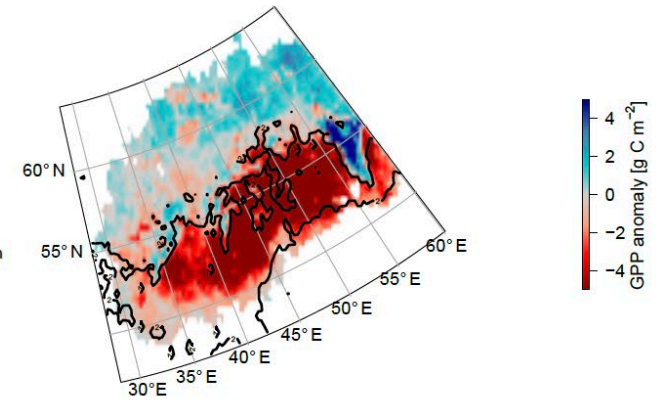
Land-cover modulation of impacts of the 2010 heatwave on gross primary productivity and water-use efficiency



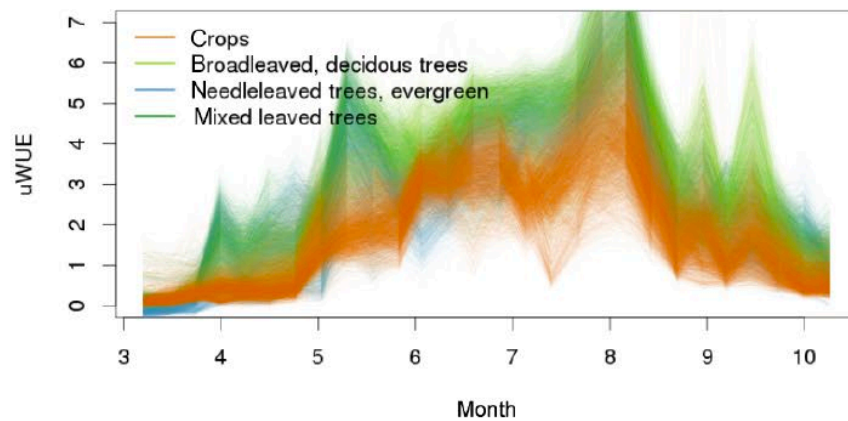
(a) Land cover



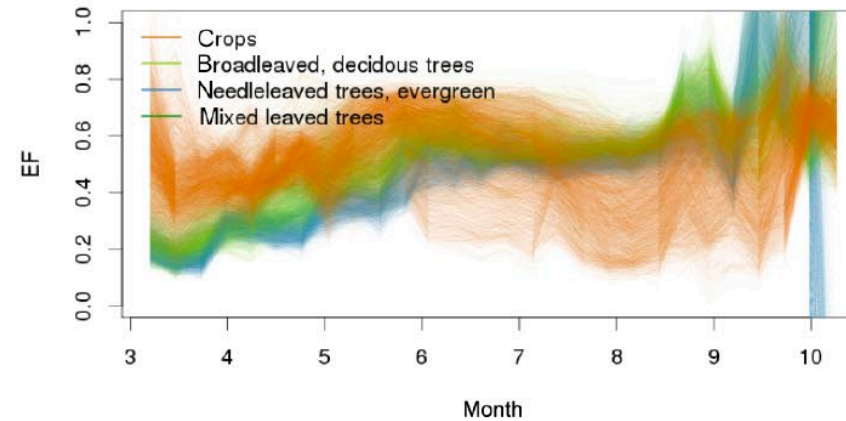
(b) Sum of GPP during the hydrometeorological summer event



(a) Underlying water use efficiency



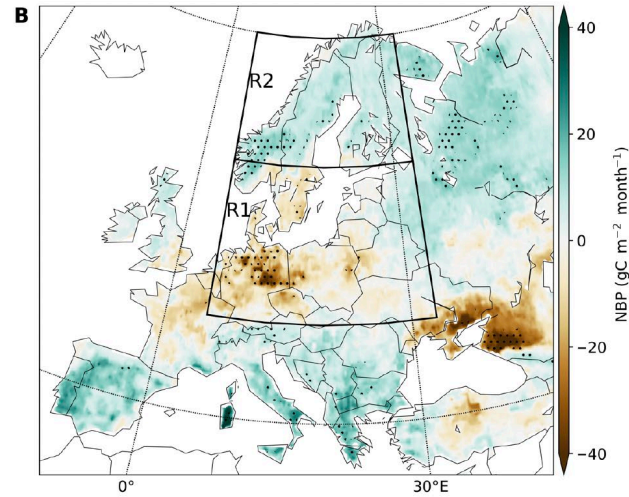
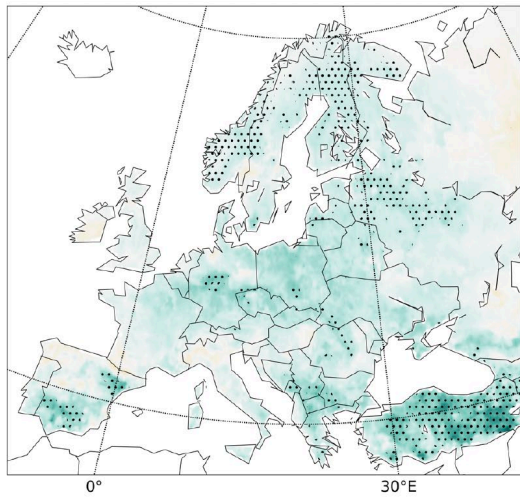
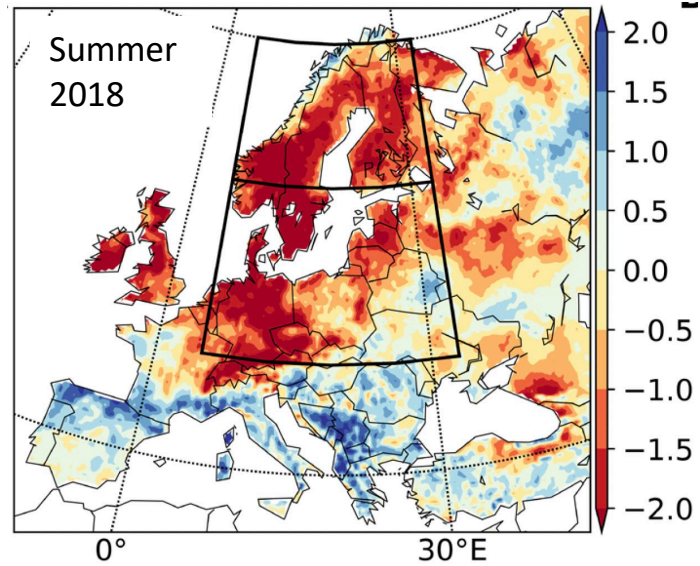
(b) Evaporative fraction



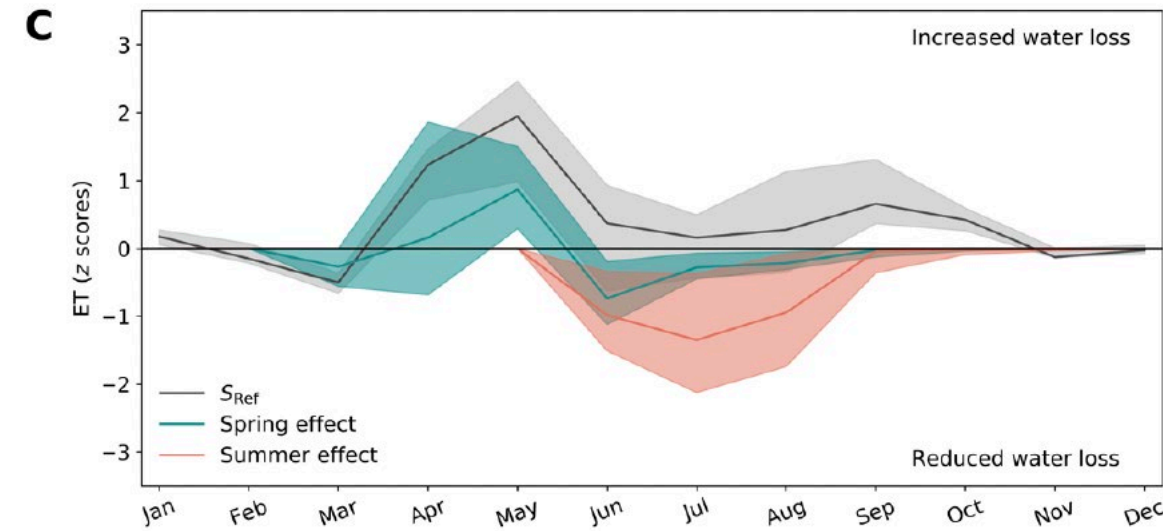
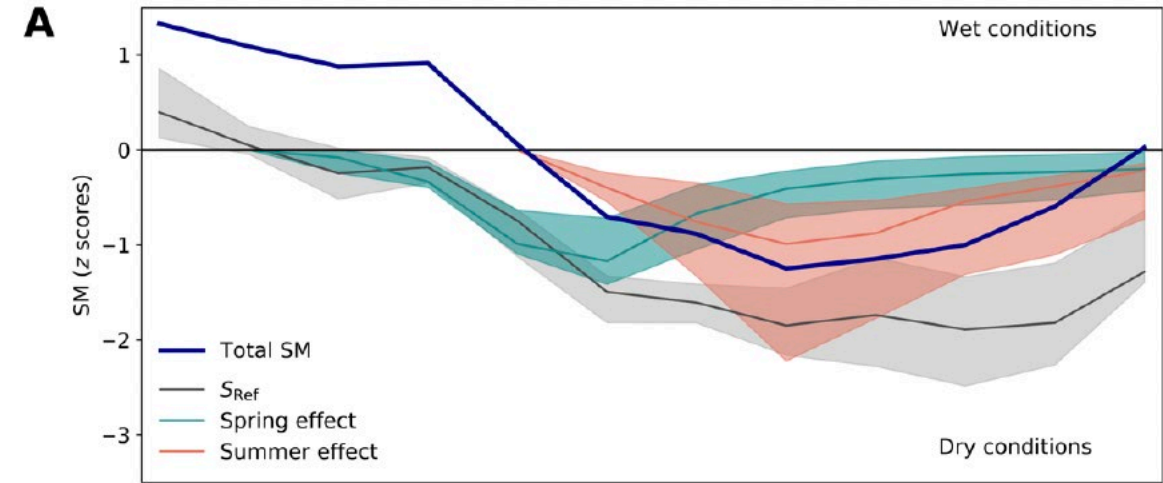
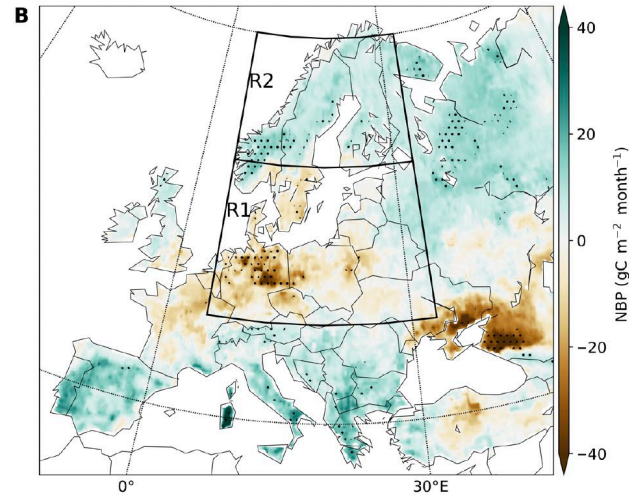
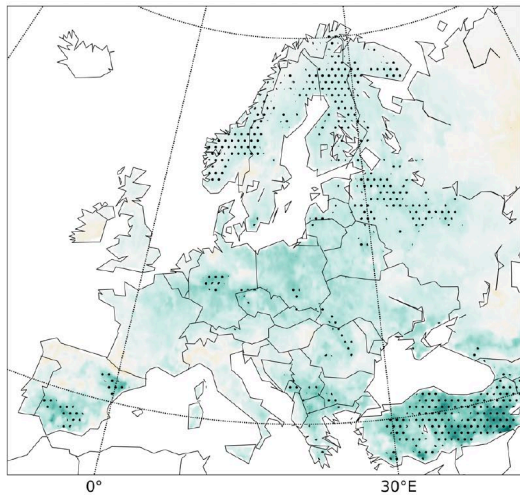
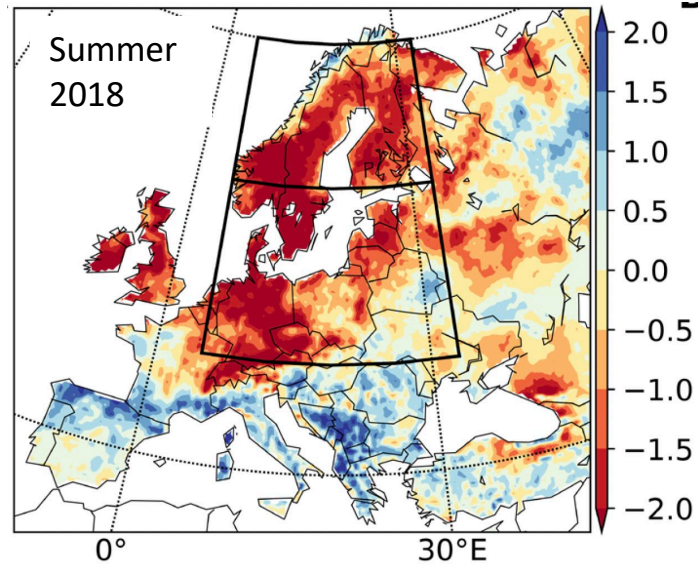
Vegetation & land-atmosphere interactions

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- **Vegetation modulation of drought/heat intensity**

Preconditioning of summer drought by spring growth

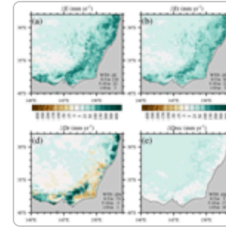


Preconditioning of summer drought by spring growth



Groundwater and root dynamics modulation of heatwaves

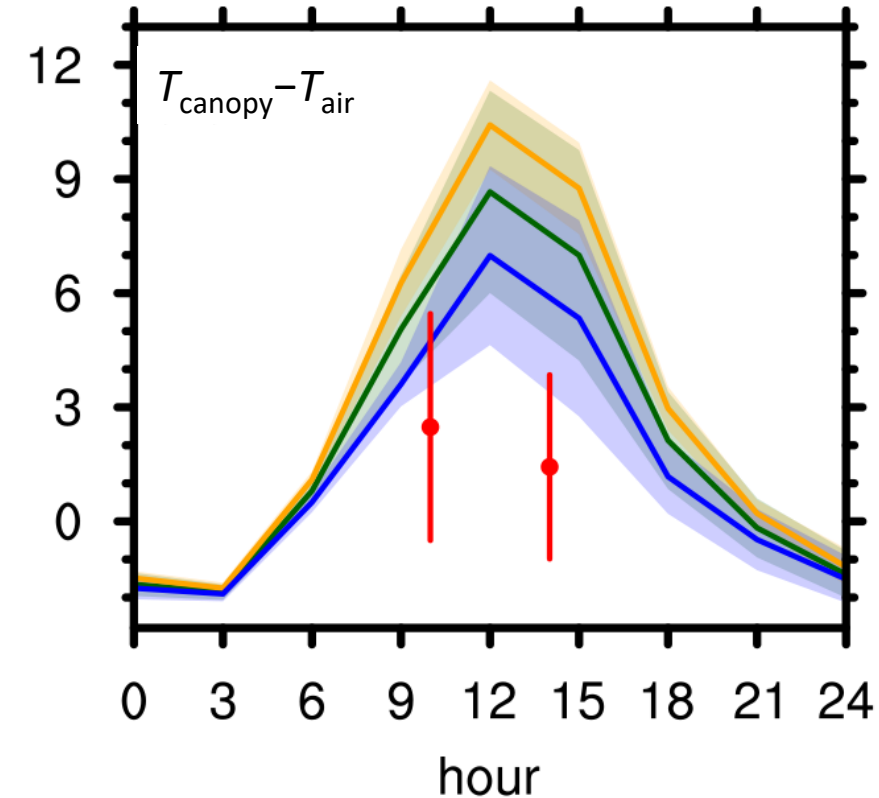
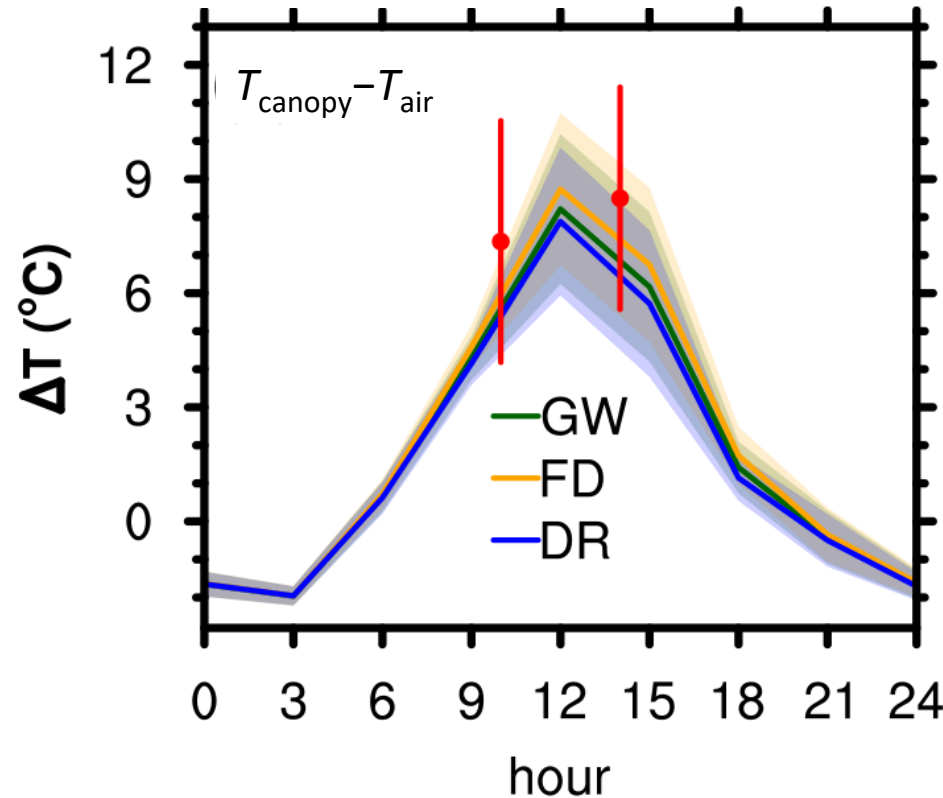
Exploring how groundwater buffers the influence of heatwaves on vegetation function during multi-year droughts



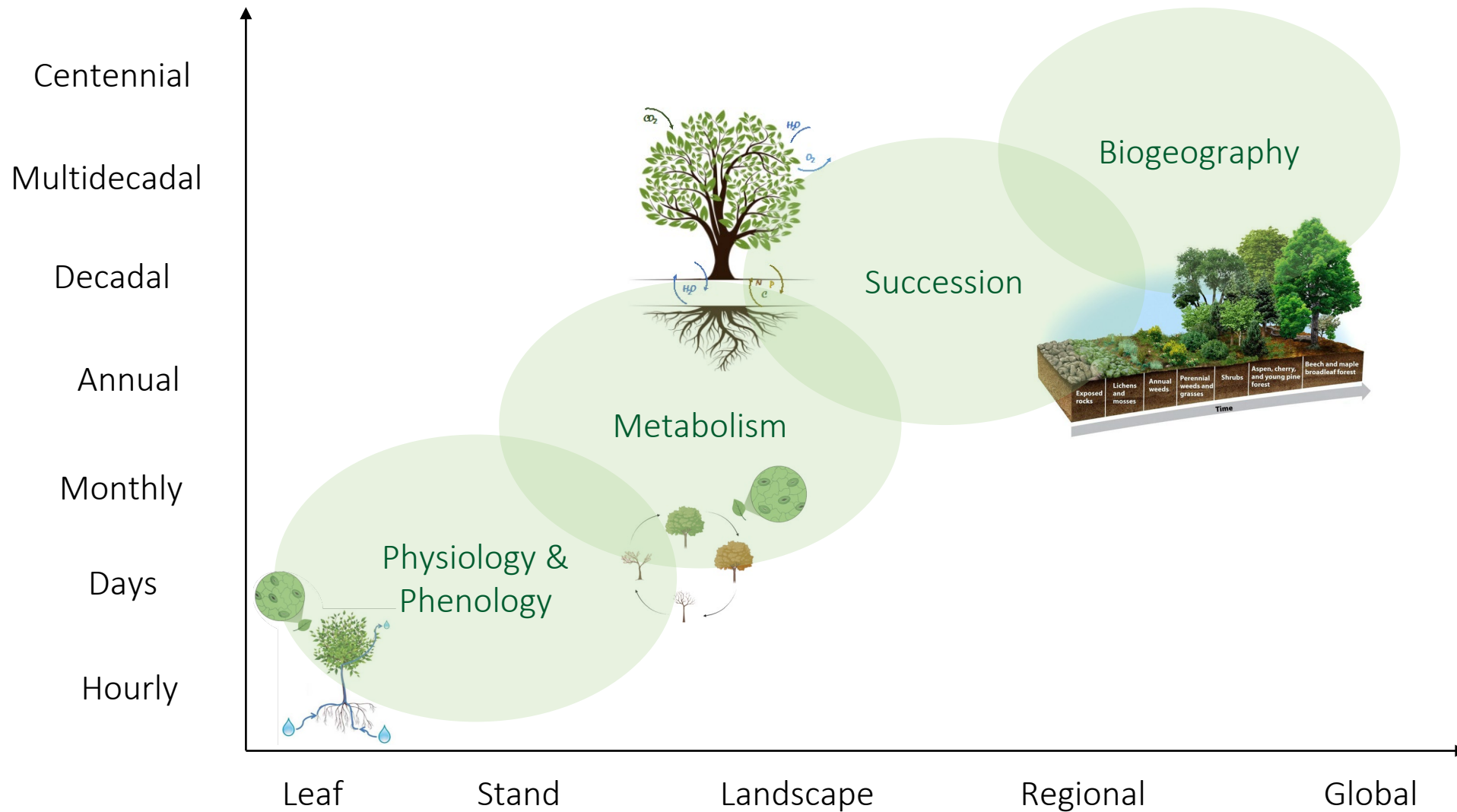
MODIS
Groundwater
Free drainage
Groundwater + deep root

Mengyuan Mu¹, Martin G. De Kauwe^{1,2}, Anna M. Ukkola¹, Andy J. Pitman¹, Weidong Guo³, Sanaa Hobeichi¹, and Peter R. Briggs⁴

Neglecting groundwater dynamics and deep roots is more likely to cause an overestimation of heat stress in shallower WTD regions (right)



Spatial and temporal scales of vegetation dynamics



Thank you for your attention

