Exploit Diurnal Cycles to Evaluate Vegetation Responses to Heat and Drought Stress

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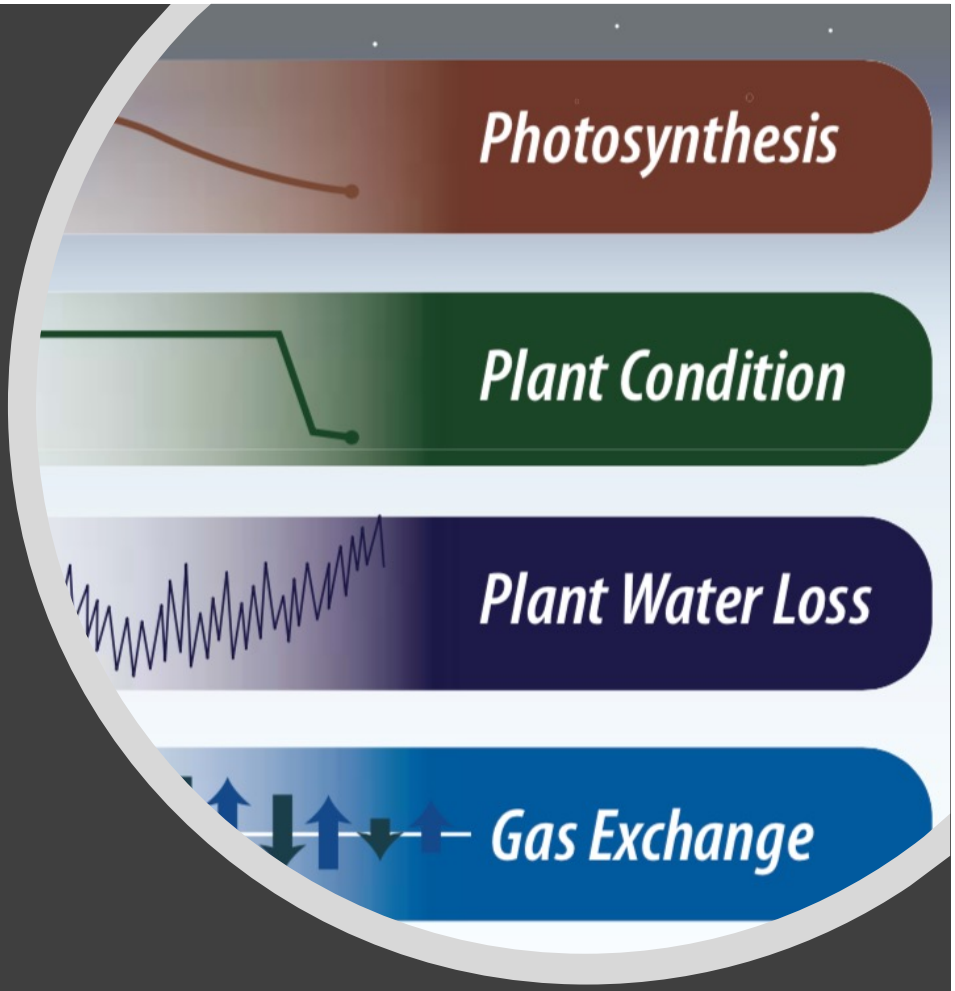
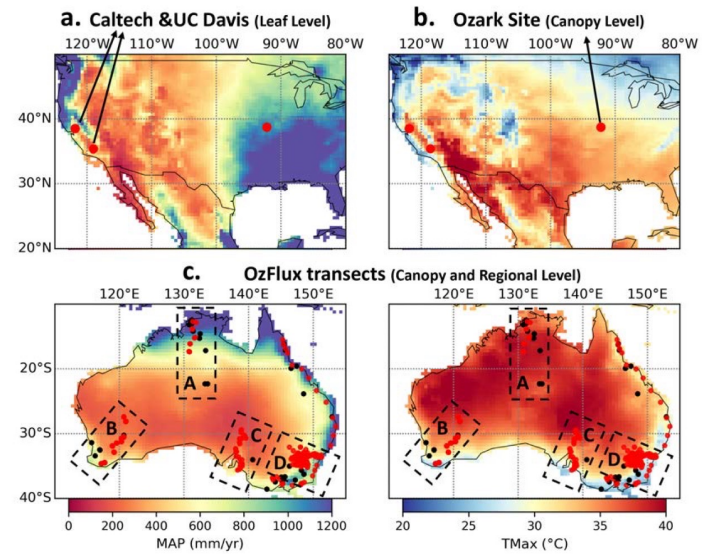


Project Framework

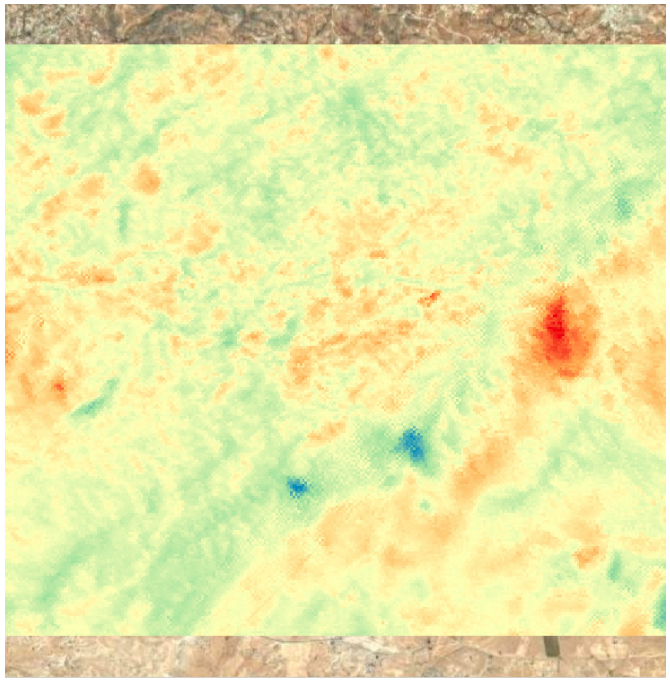
- Leaf Level
  - How ET, photosynthesis, stomatal conductance, and SIF respond to a range of water and temperature stress?
- Site Level
  - GPP & ET: Synchronization vs. Asynchronization?
- Regional Level
  - Variations of energy, water, and carbon cycles for different land cover types in the climate sensitive Central Great Plains and the OzFlux Australia transits.

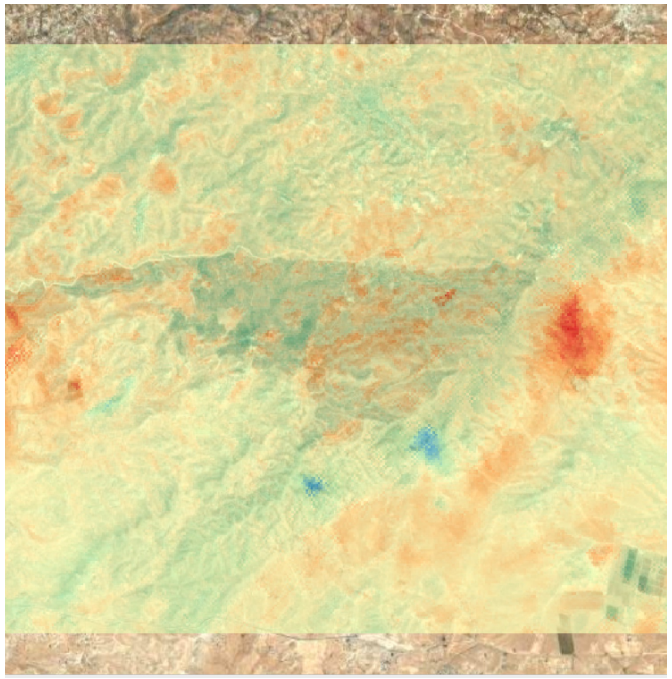


- Parallel efforts in ecosystem modeling - CliMA
  - test theories of stomatal optimization and their impacts on carbon and water fluxes
  - interpolate regional ECOSTRESS observations captured at different local times.

Site Level: case study in semi-arid vegetation

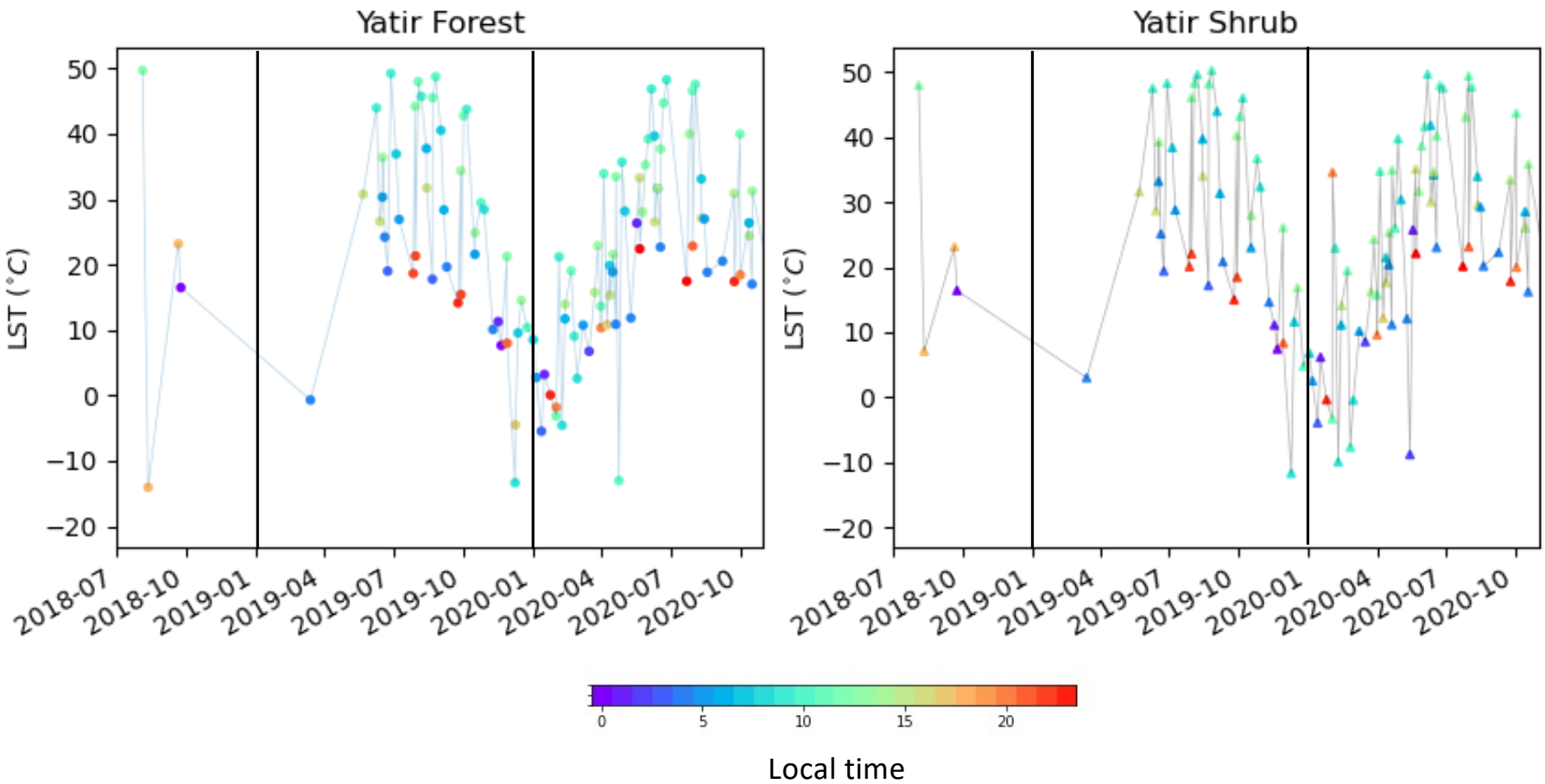
LST Distribution (~12 pm, Jun 29, 2019, Yatir Forest, Israel)





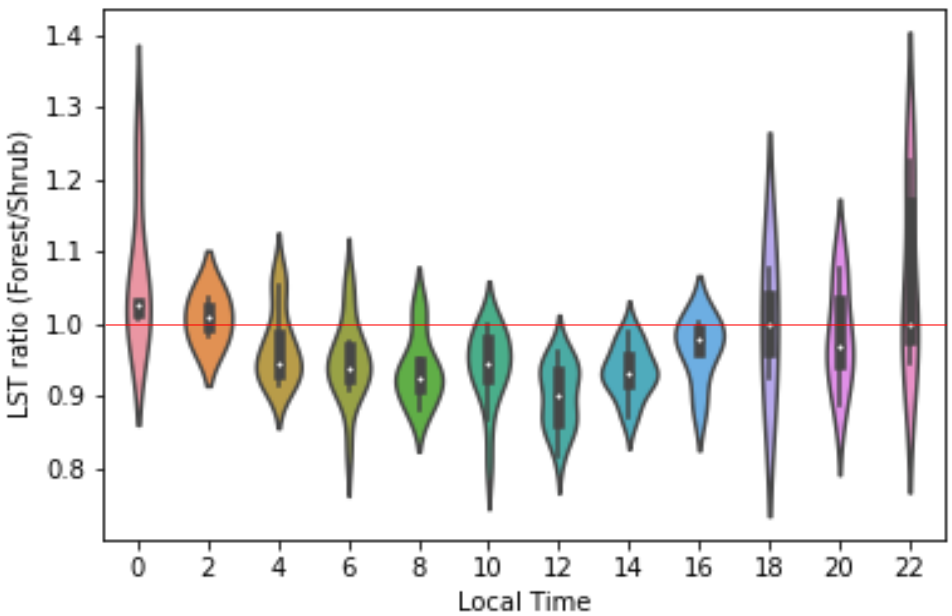
- Surface albedo (and surface slopes) and ET are both important for LST

ECOSTRESS Sampling over Yatir forest/shrubland



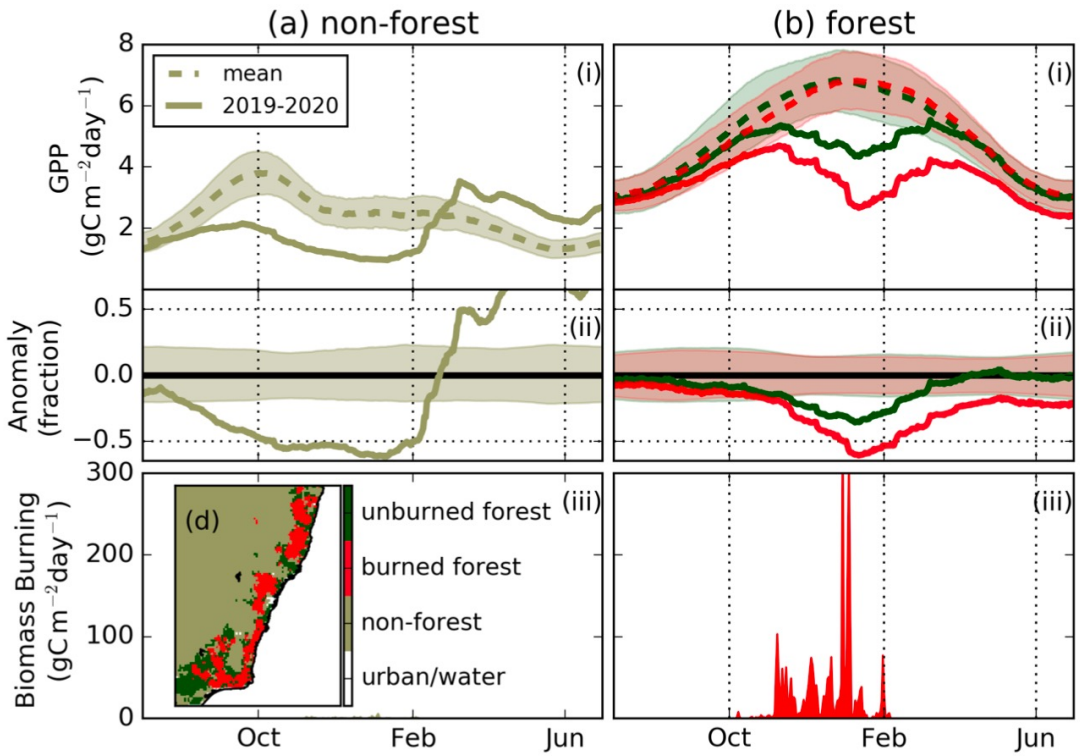
Differences in LST between forest and shrub sites

- Forest has a cooler surface at noon, but the differences are more diverse at other times.



Regional Level: drought and fire in Australia 2019-2020

2019-2020 Extreme heat and bush fire in Southeast Australia



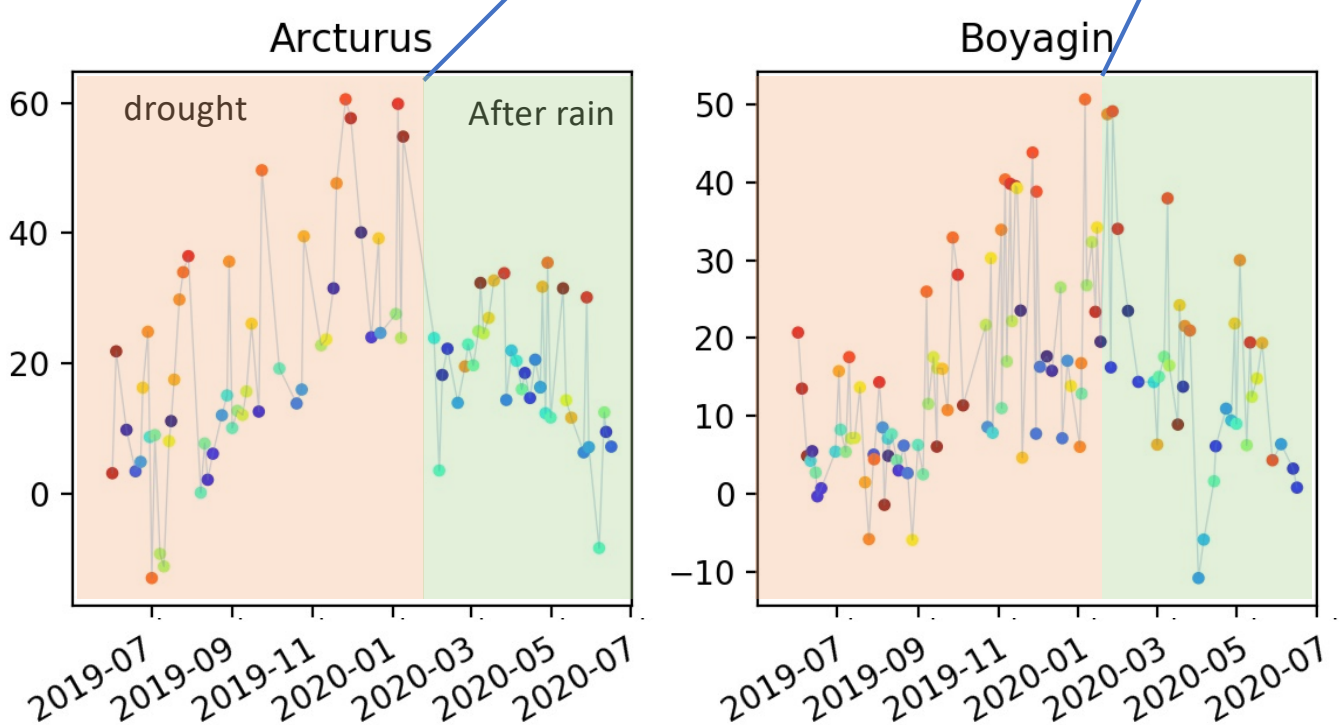
Byrne et al., AGU Advances (in review)

Next: ECOSTRESS LST & ET data for energy balance & vegetation stress analysis before and after the bush fire

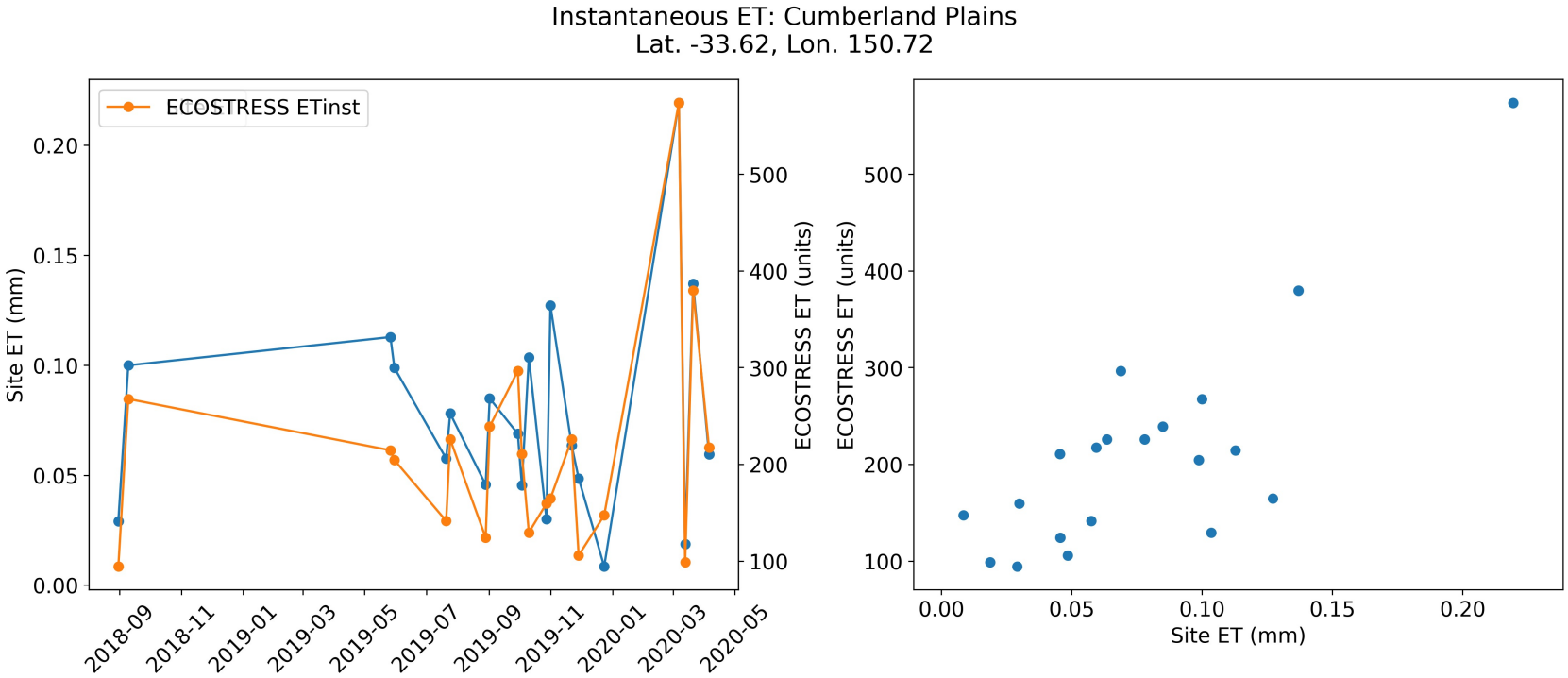
- burned vs. unburned
- forest vs. shrub

ECOSTRESS LST retrievals at Australia Ozflux sites

Lower LST, smaller diurnal amplitude after the drought spell



Challenges: varying temporal sampling with interannual, seasonal, synoptic, and diurnal variations



Important tool: CliMa-Land model

Model Framework

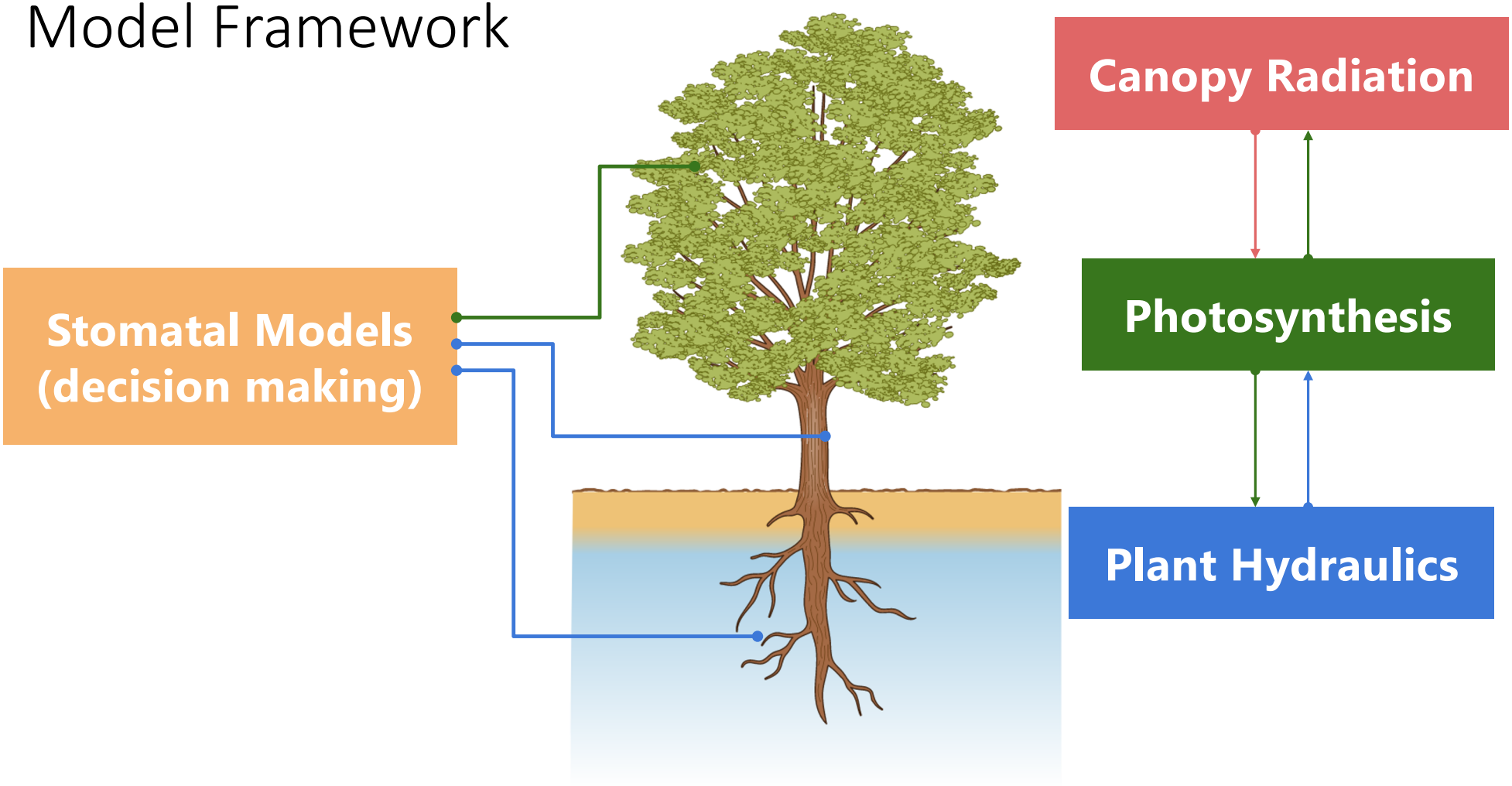
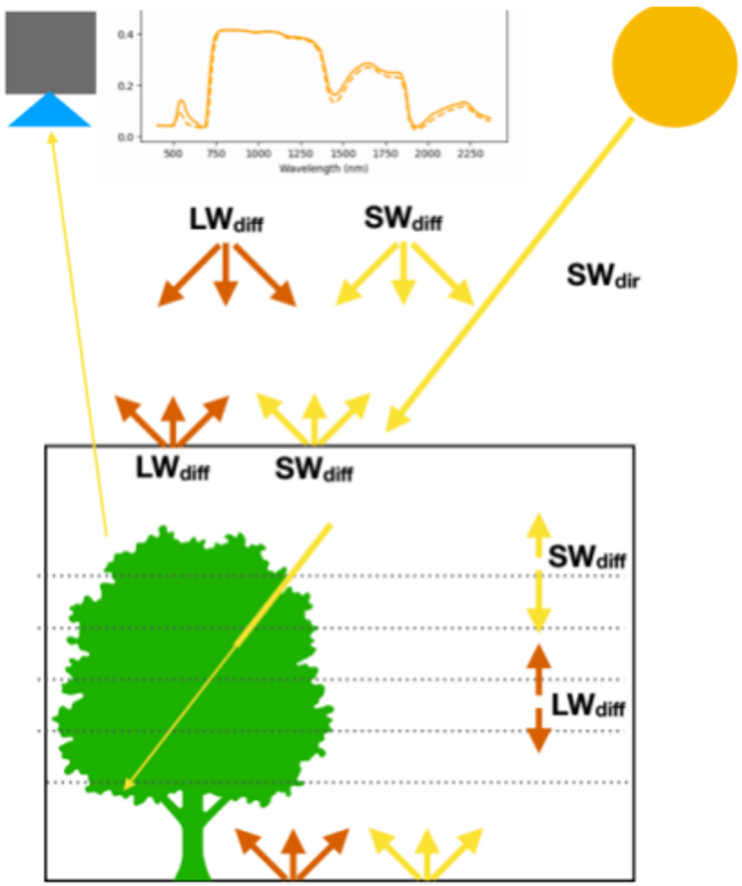


Image adapted from Wang et al. (2020)

Canopy Radiation

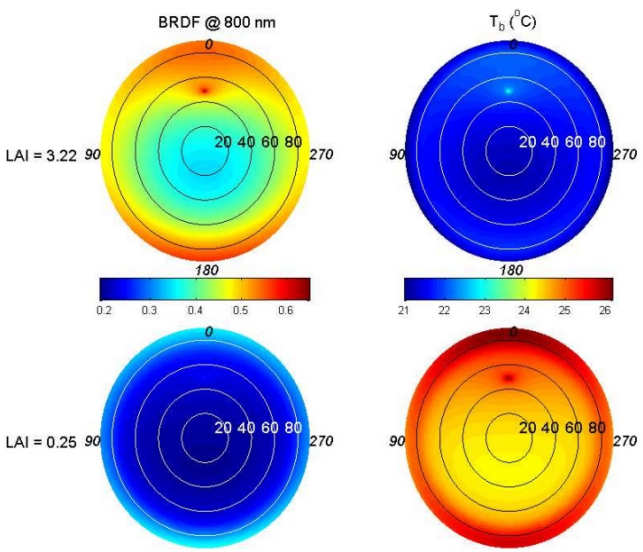


Supported Models

- mSCOPE + FluSpect model
- Big leaf model

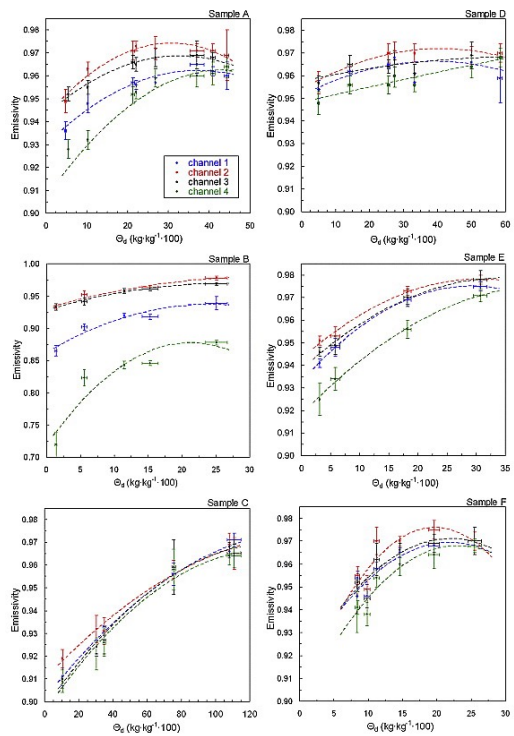
How could CLiMA help Ecostress community?

LST directionality effects (Canopy-Observer directional radiance can be computed)



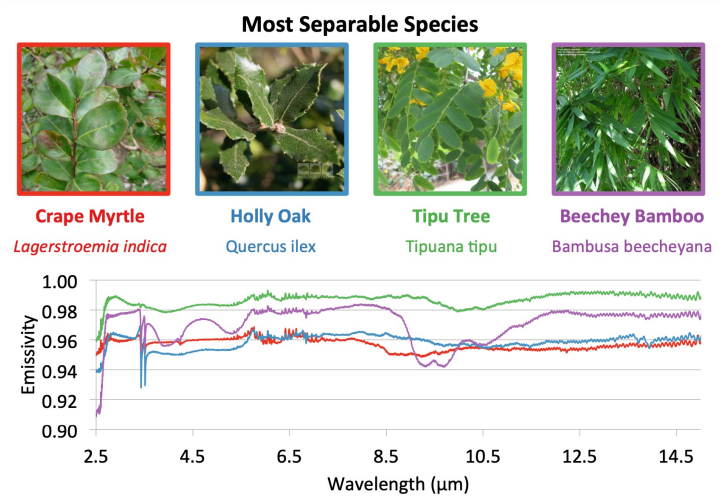
https://bg.copernicus.org/articles/6/3109/2009/bg-6-3109-2009.pdf

Emissivity could be state-dependent (example here for soils)



https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2007JF000749

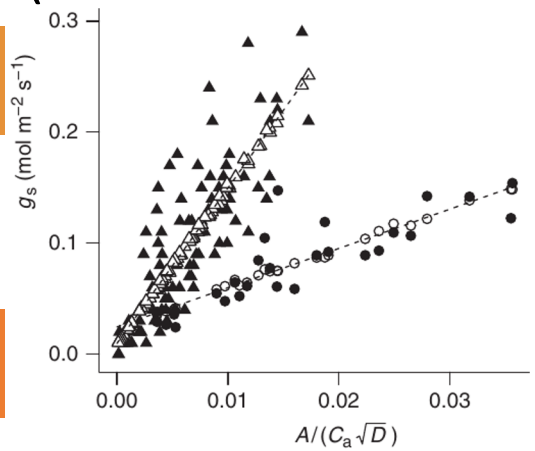
Emissivity of leaves is not always 0.98 (change of 0.02 can be almost 2K LST error)



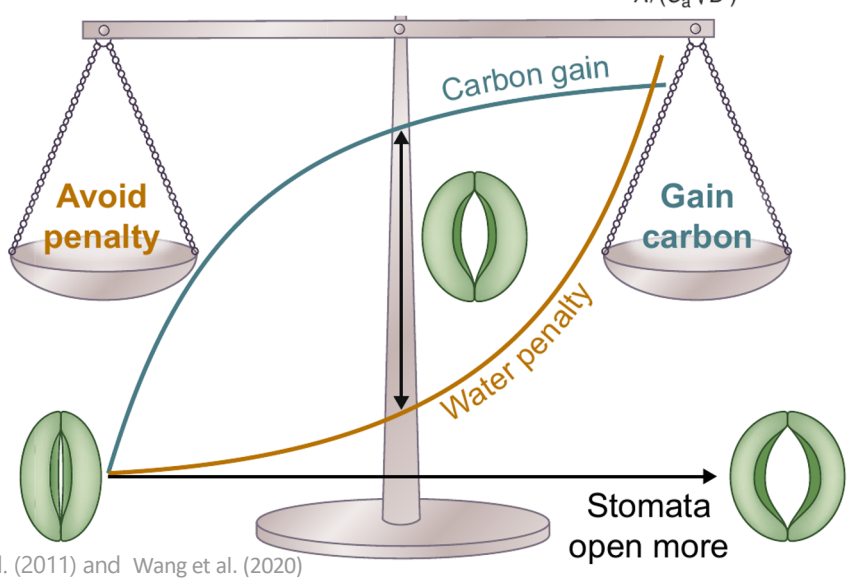
From Susan Meerdink:
https://hyspiri.jpl.nasa.gov/downloads/2016_Workshop/day3/9_2016_Meerdink_HyspIRI_Workshop.pdf

Stomatal Models (decision making)

Statistical models



Optimization models



Images from Medlyn et al. (2011) and Wang et al. (2020)

Empirical Models

- Ball-Berry
- Leuning
- Medlyn
- Gentine

Optimization Models

- Wolf-Anderegg-Pacala
- WAP MOD
- Sperry
- Eller
- Wang

+ prognostic stomatal conductance, delayed response

Thank you!