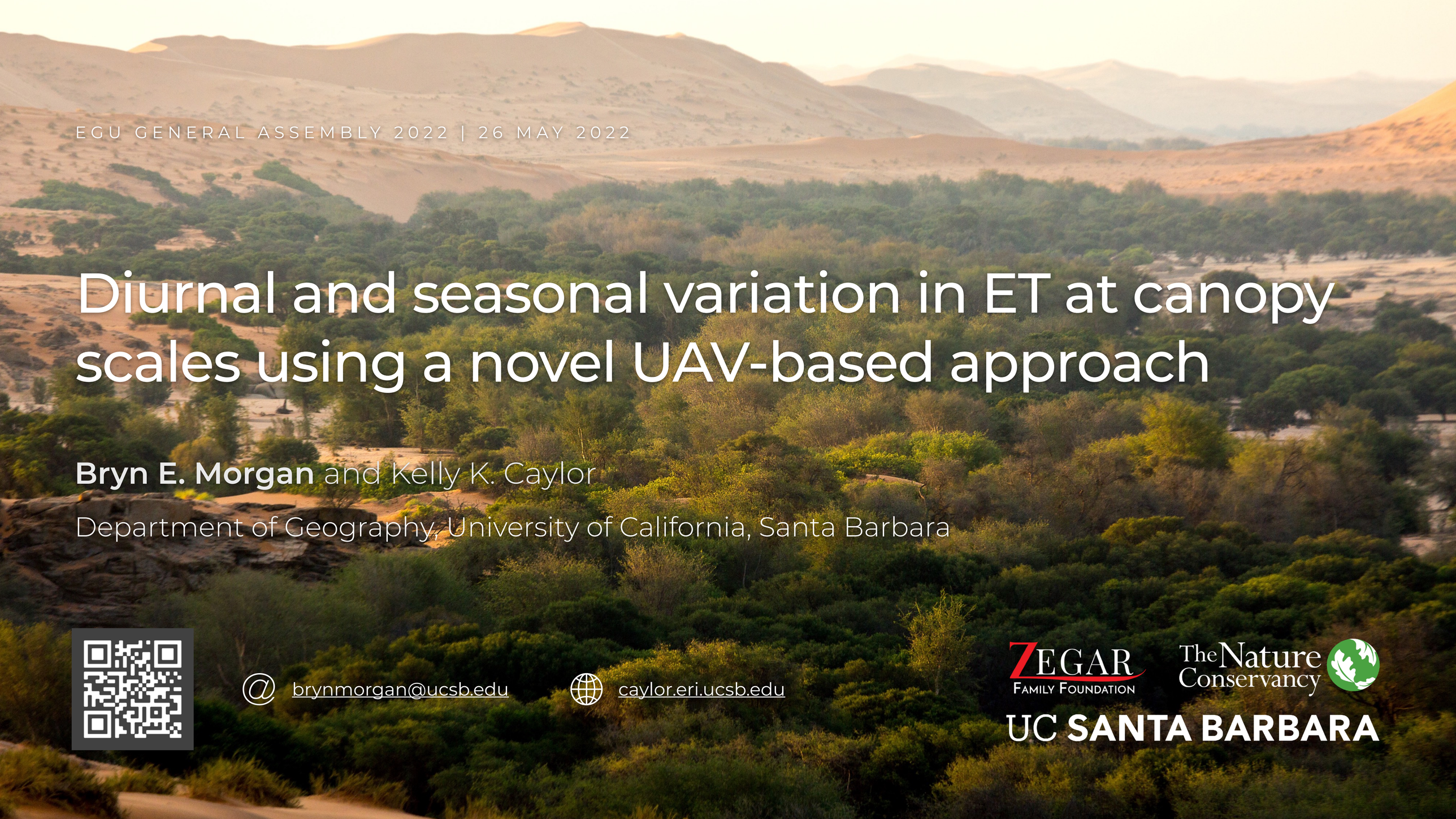

EGU GENERAL ASSEMBLY 2022 | 26 MAY 2022

Diurnal and seasonal variation in ET at canopy scales using a novel UAV-based approach

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ZEGAR Family Foundation

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UC SANTA BARBARA

The Importance of Transpiration

WATER BALANCE

$$\frac{d\theta}{dt} = P - T - E - L - Q$$

ENERGY BALANCE

$$\rho C_p \frac{dT}{dt} = R_n - H - \lambda T - \lambda E - G$$

CARBON BALANCE

$$\frac{dB}{dt} = \epsilon T - R_a - R_H - E_C$$

How ecosystems will respond to climate change will depend on how individual plants regulate carbon, water, and energy fluxes under changing conditions of water availability and atmospheric demand.

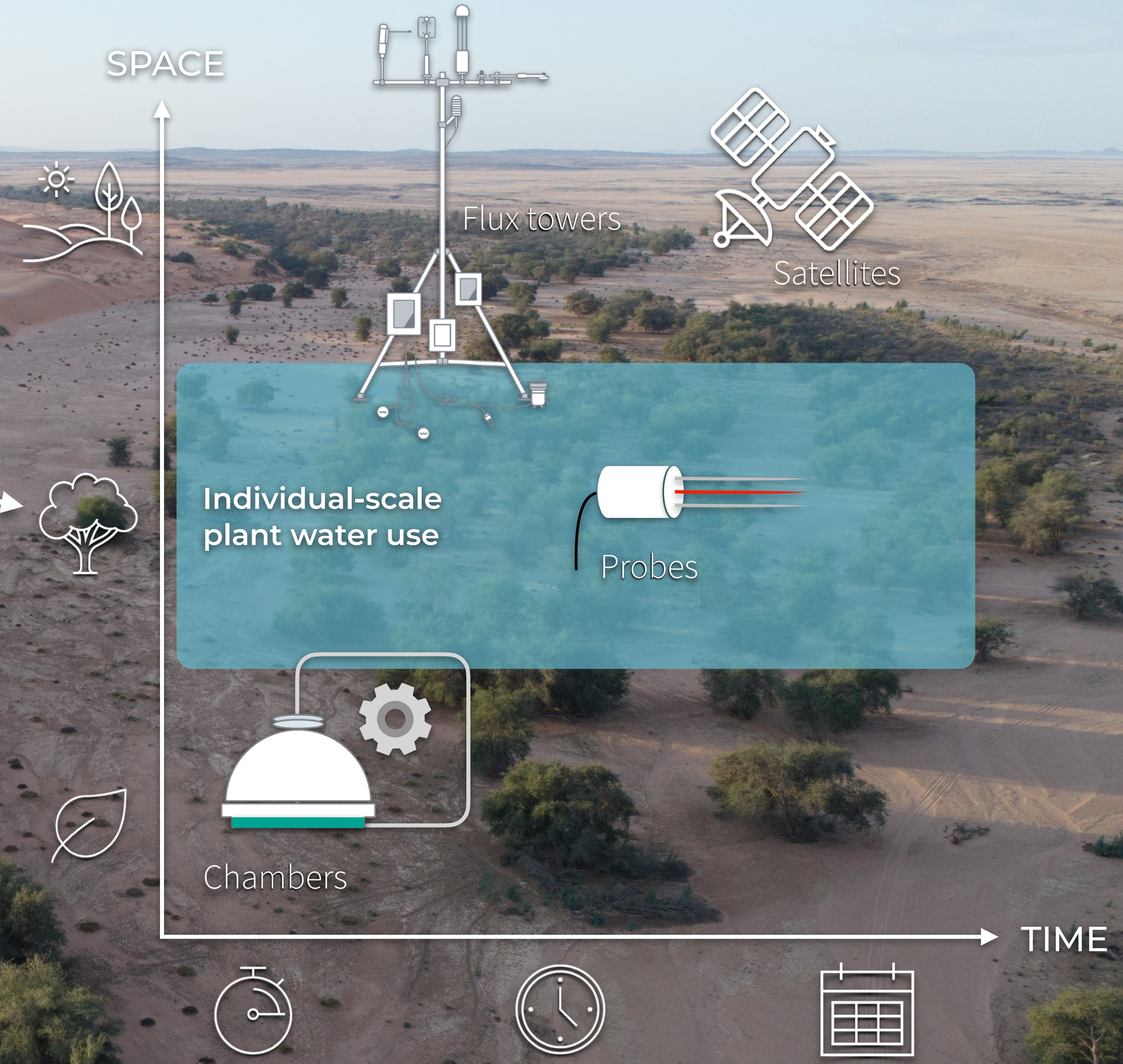
Transpiration acts as the key link between the water, carbon, and energy cycles.

Thus, knowledge of the differential rates of water uptake at the individual level under varying conditions is critical for predicting how ecosystem structure and function might shift in response to climate-induced water stress.


How much
water is this
tree using?

How much water is this tree using?

For most natural ecosystems, we have limited ability to observe or measure individual-scale transpiration.



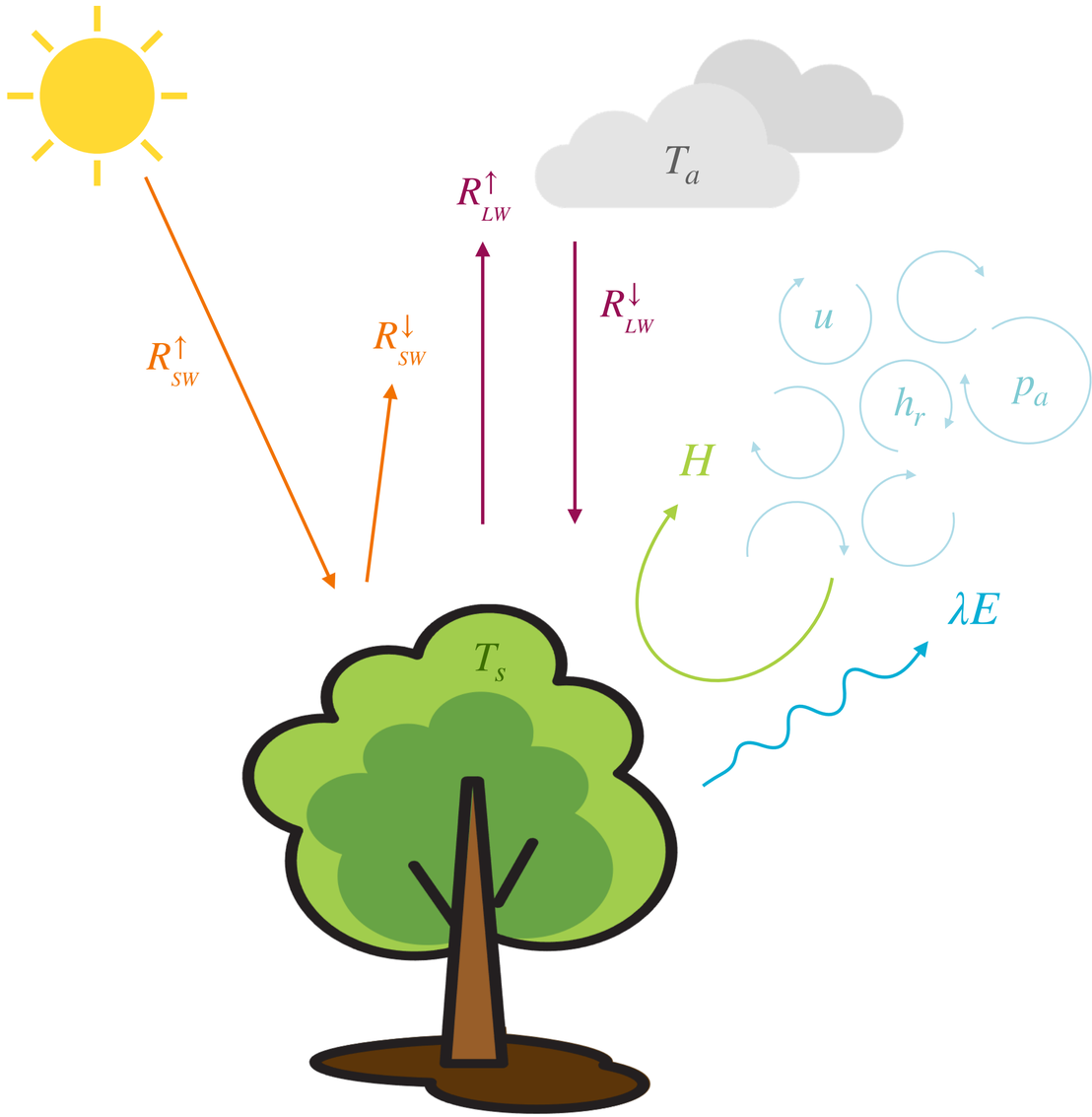
Plant water use measurement strategies

MEASURING CANOPY ENERGY BALANCE

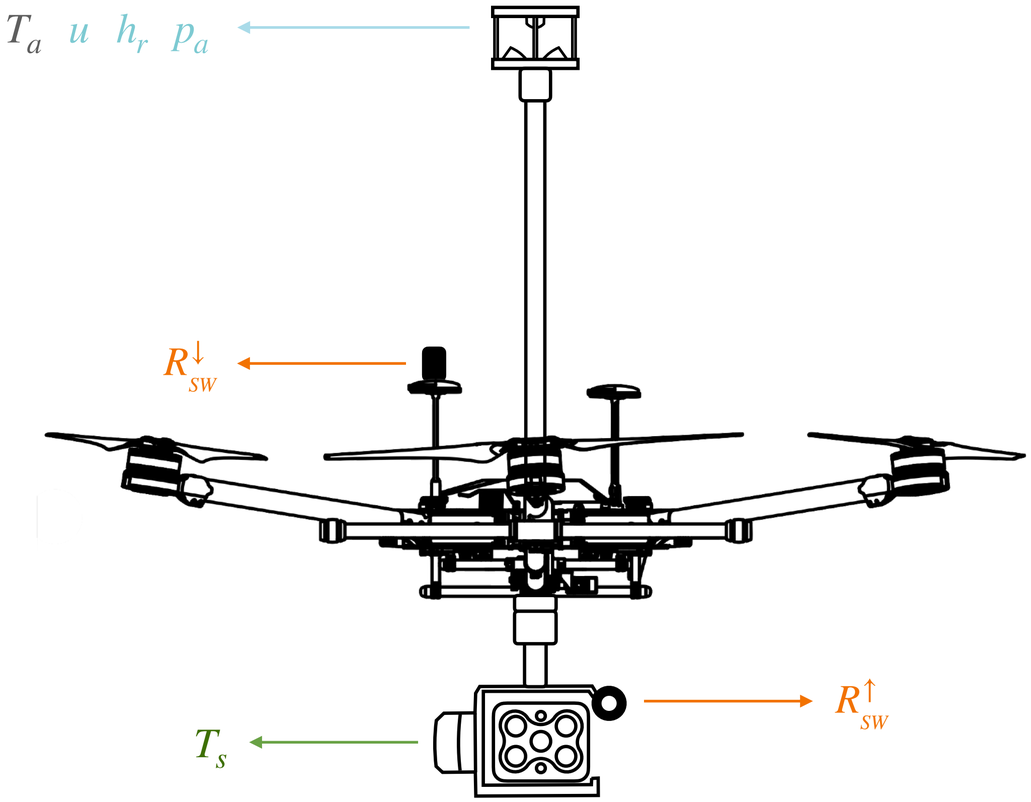
Both radiative and turbulent fluxes depend on characterizing surface temperature as well as a host of atmospheric parameters.

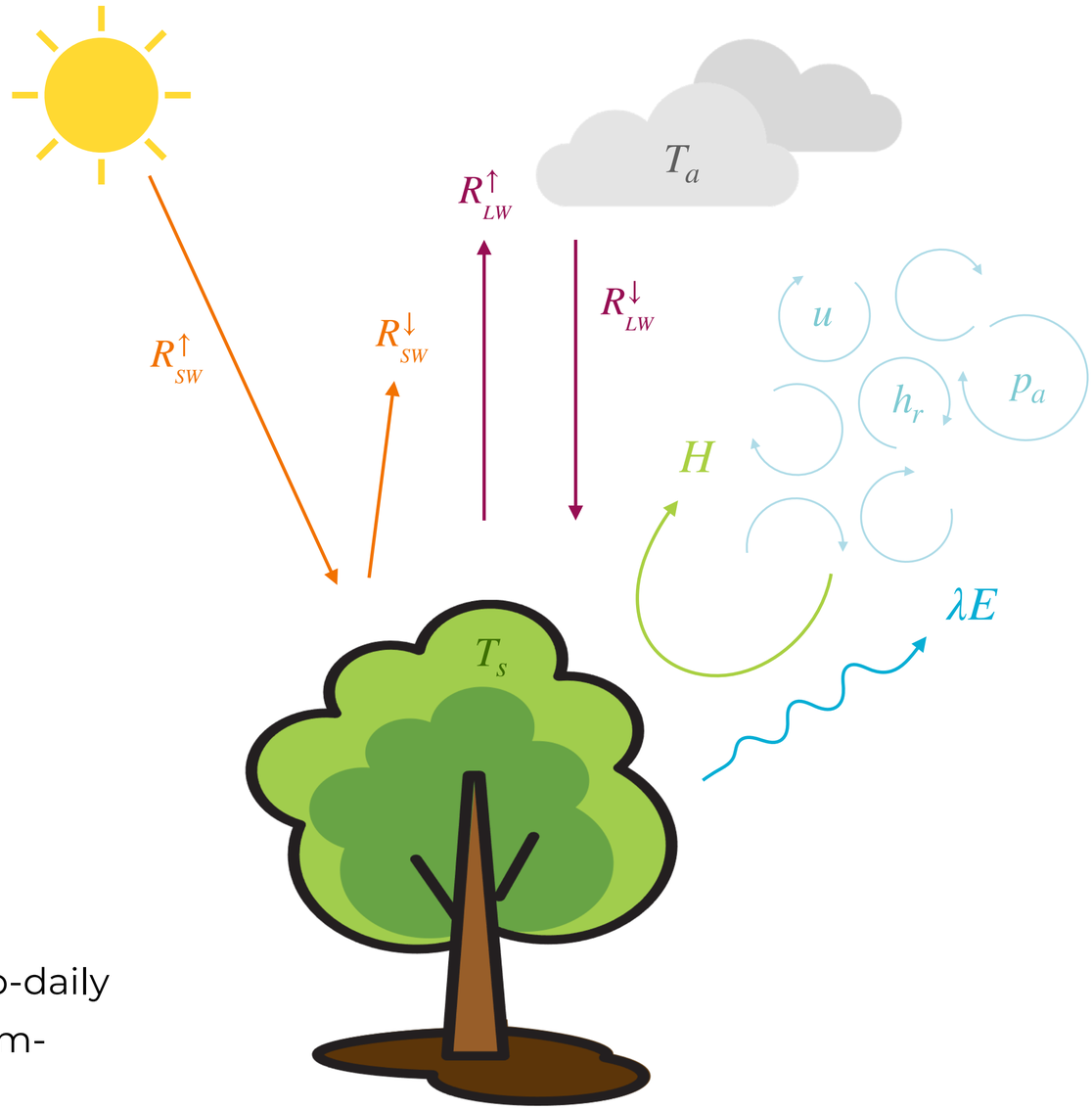
$$\rho C_p \frac{dT}{dt} = R_n - H - \lambda T - \lambda E - G$$

Most thermal remote sensing platforms can't provide these data or resolve canopy water use at the individual level... but UAVs can.



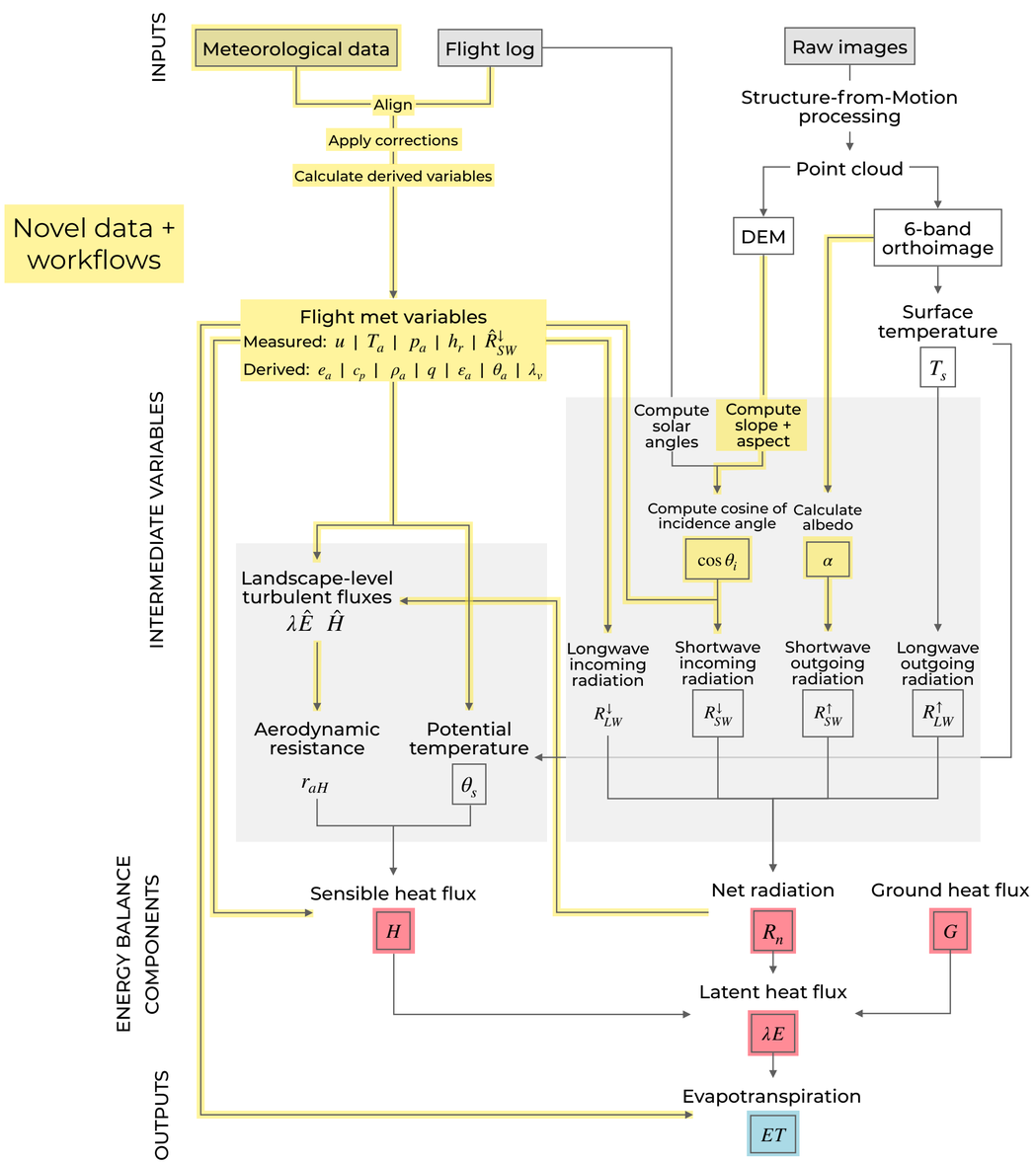
MEASURING CANOPY ENERGY BALANCE

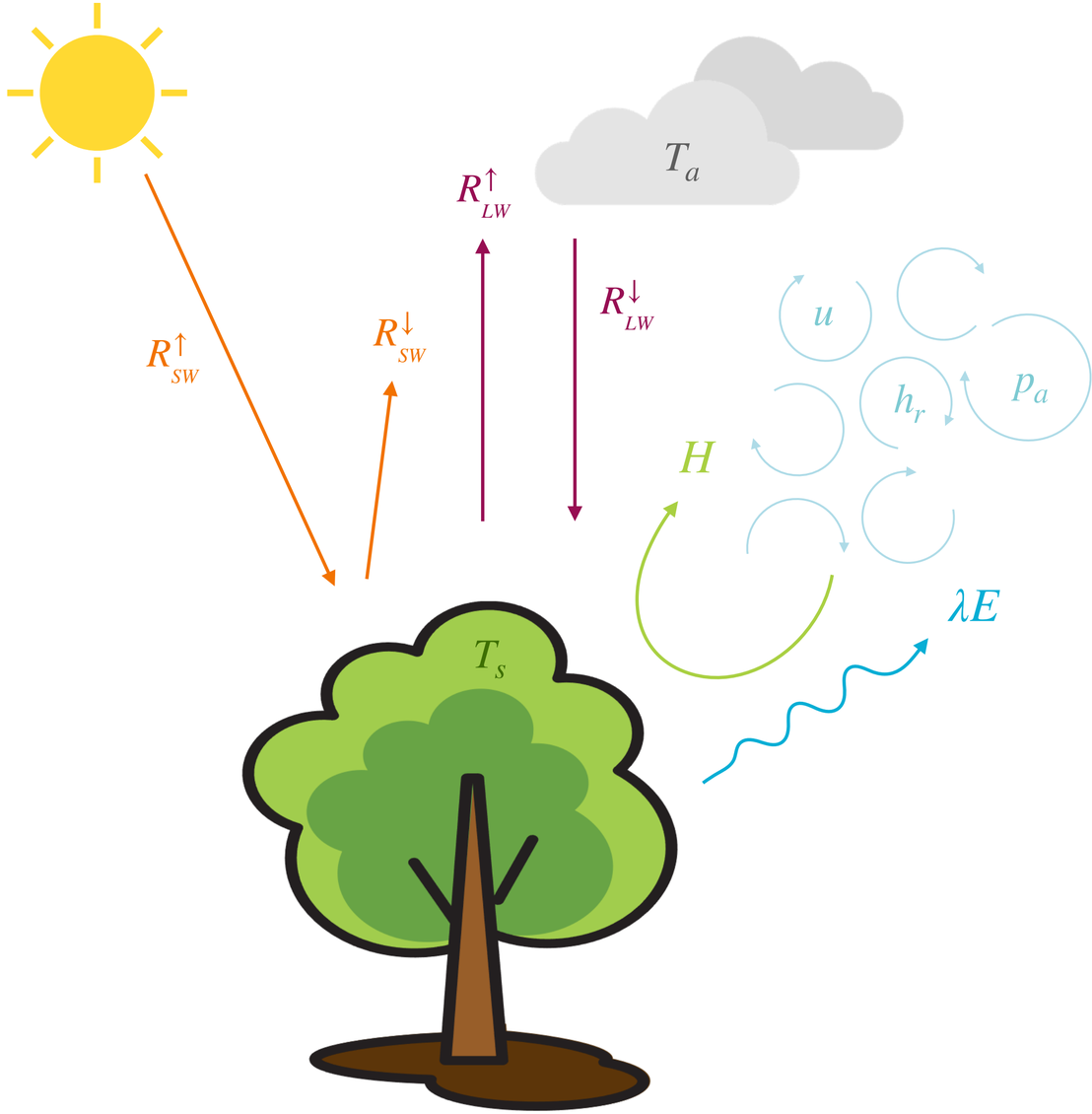




We have designed a platform for studying canopy-scale ET at sub-daily frequencies using a UAV platform equipped with a suite of custom-integrated, low-cost environmental sensors.

MEASURING CANOPY ENERGY BALANCE





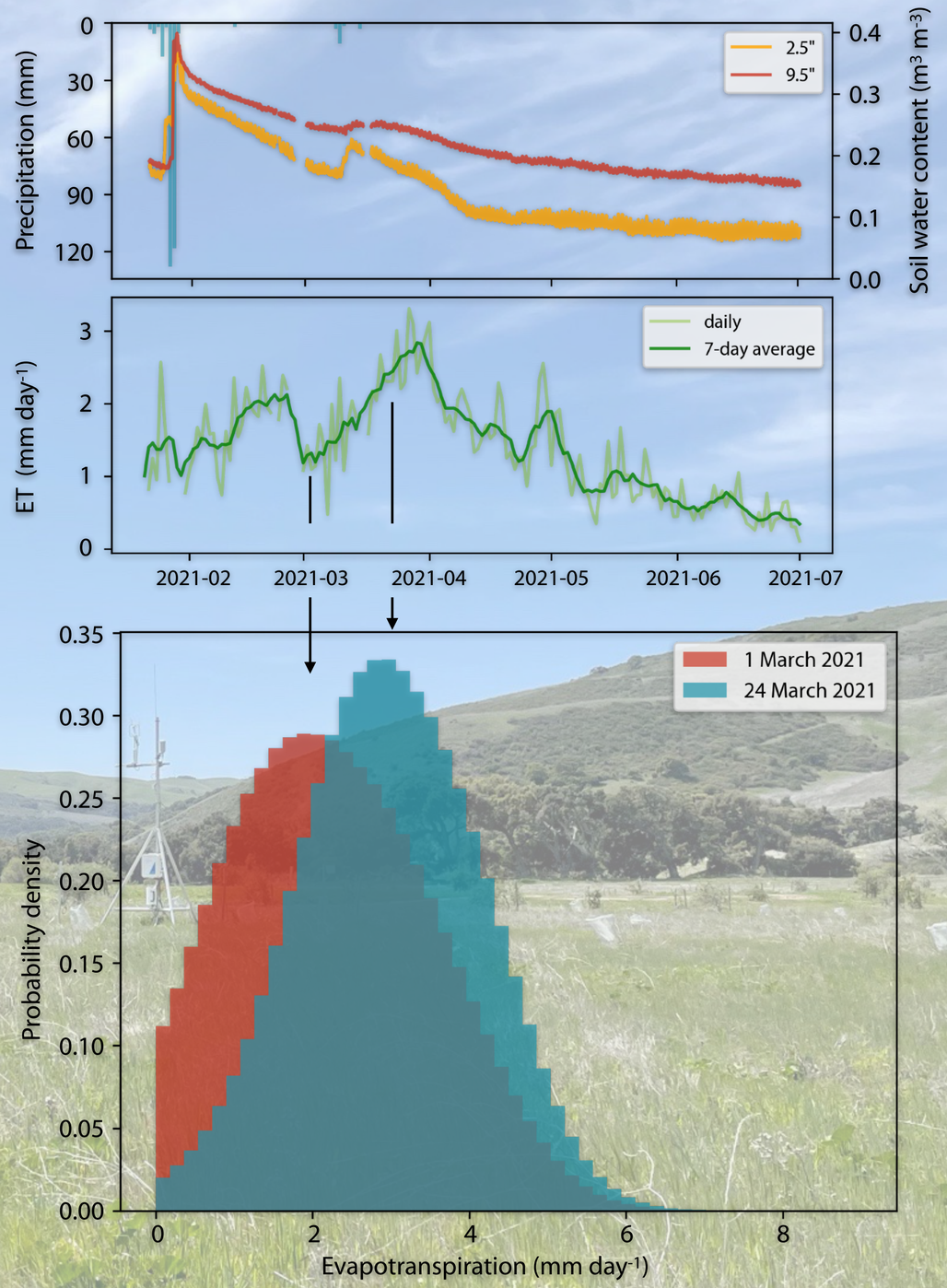
VALIDATION | GRASSLAND ET

To validate our approach, we set up an eddy covariance tower in a native southern California grassland.

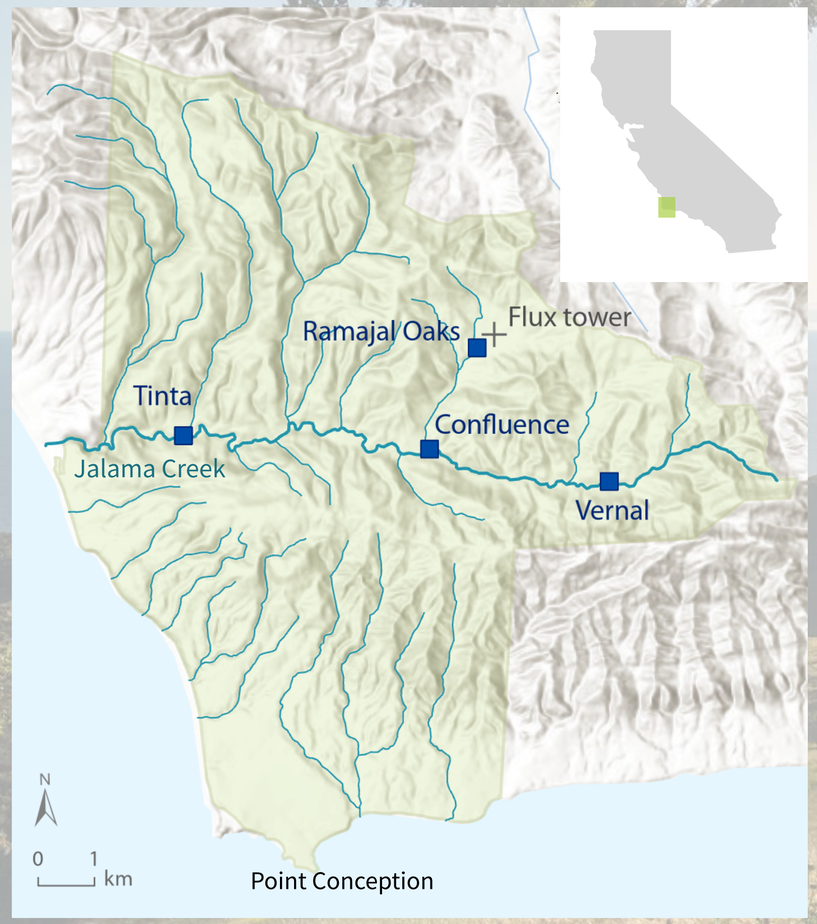
We conducted a series of flights during the growing seasons of 2021 and 2022.

VALIDATION | GRASSLAND ET

UAV-derived ET is within the range of error of eddy covariance measurements.



RIPARIAN OAK WOODLAND

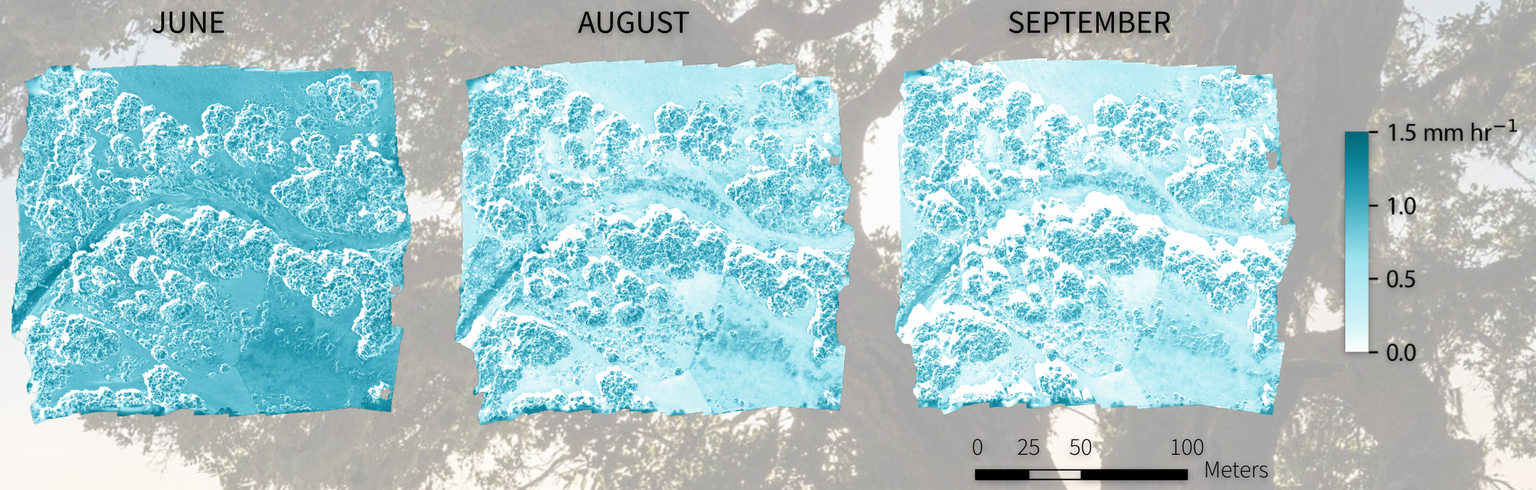


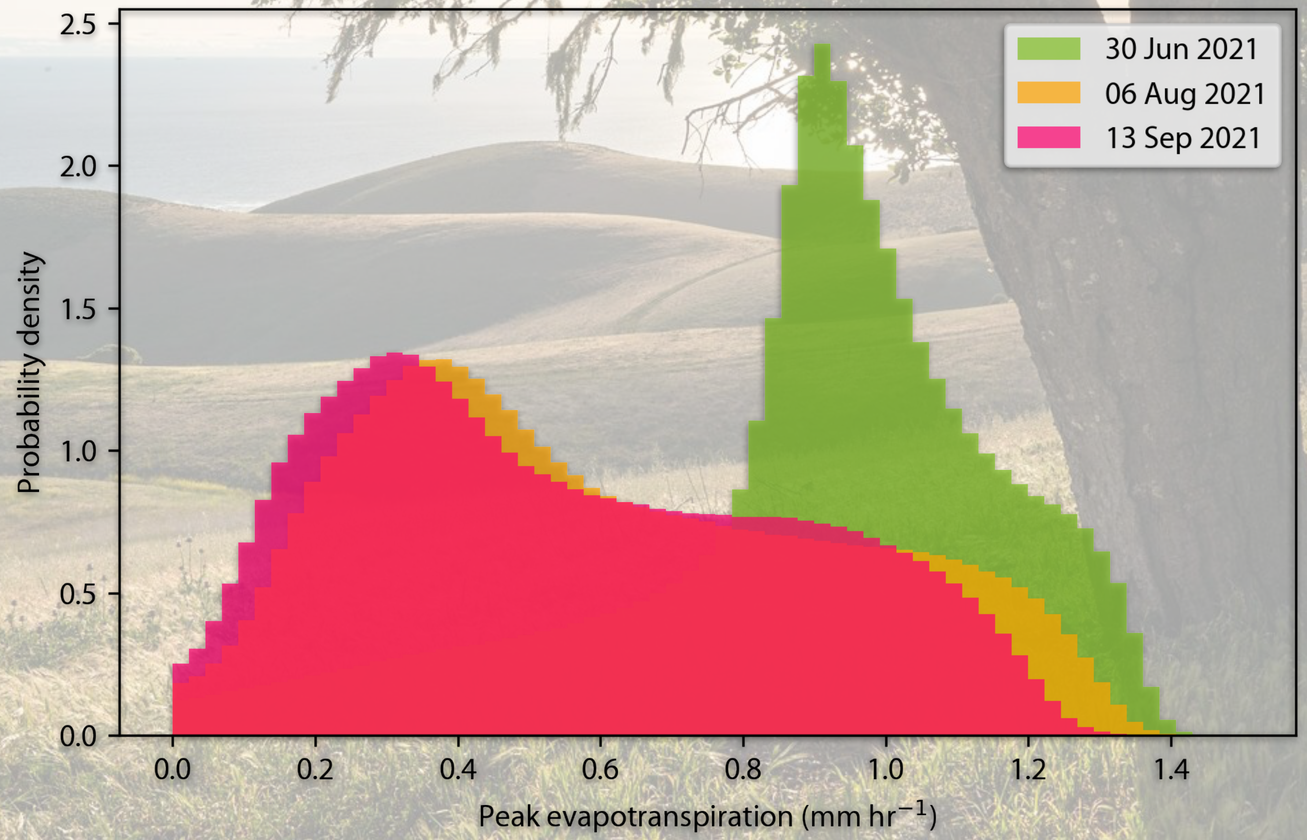
Summer 2021

Monthly + diurnal flights at 4 riparian oak woodland sites along the Jalama Creek watershed to characterize canopy response to decreasing water availability into the summer and changing atmospheric demand throughout the day.

RIPARIAN OAK WOODLAND

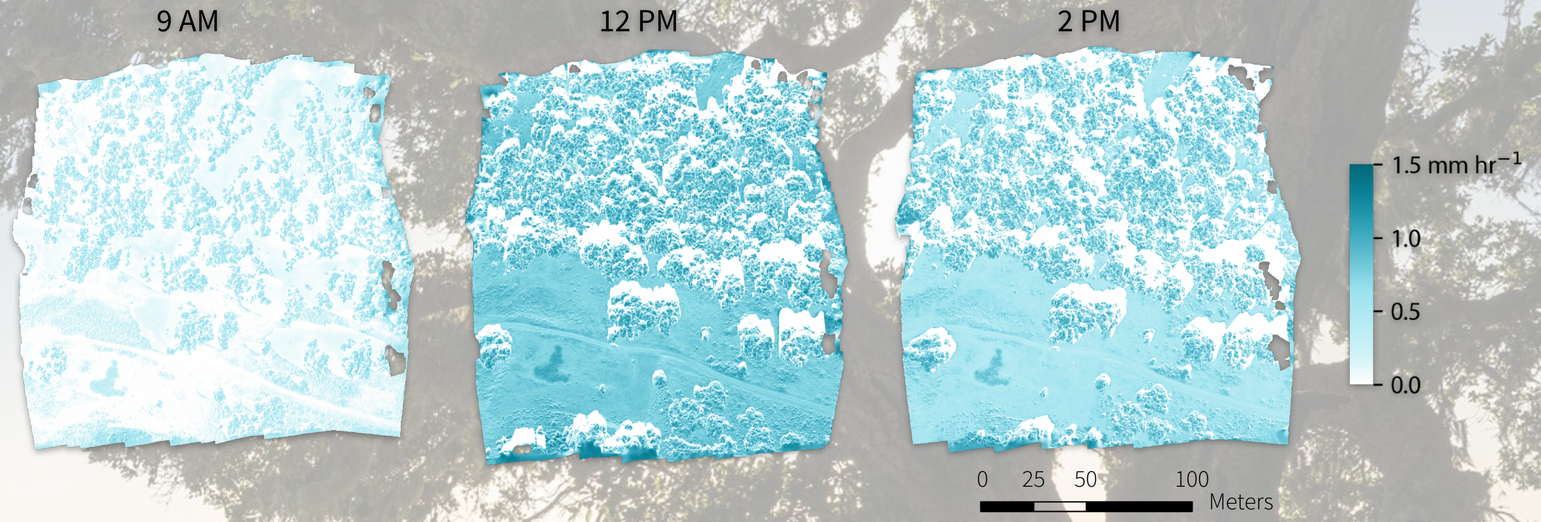
UAV-derived ET shows decreasing water use by riparian oaks over the course of the summer dry season.

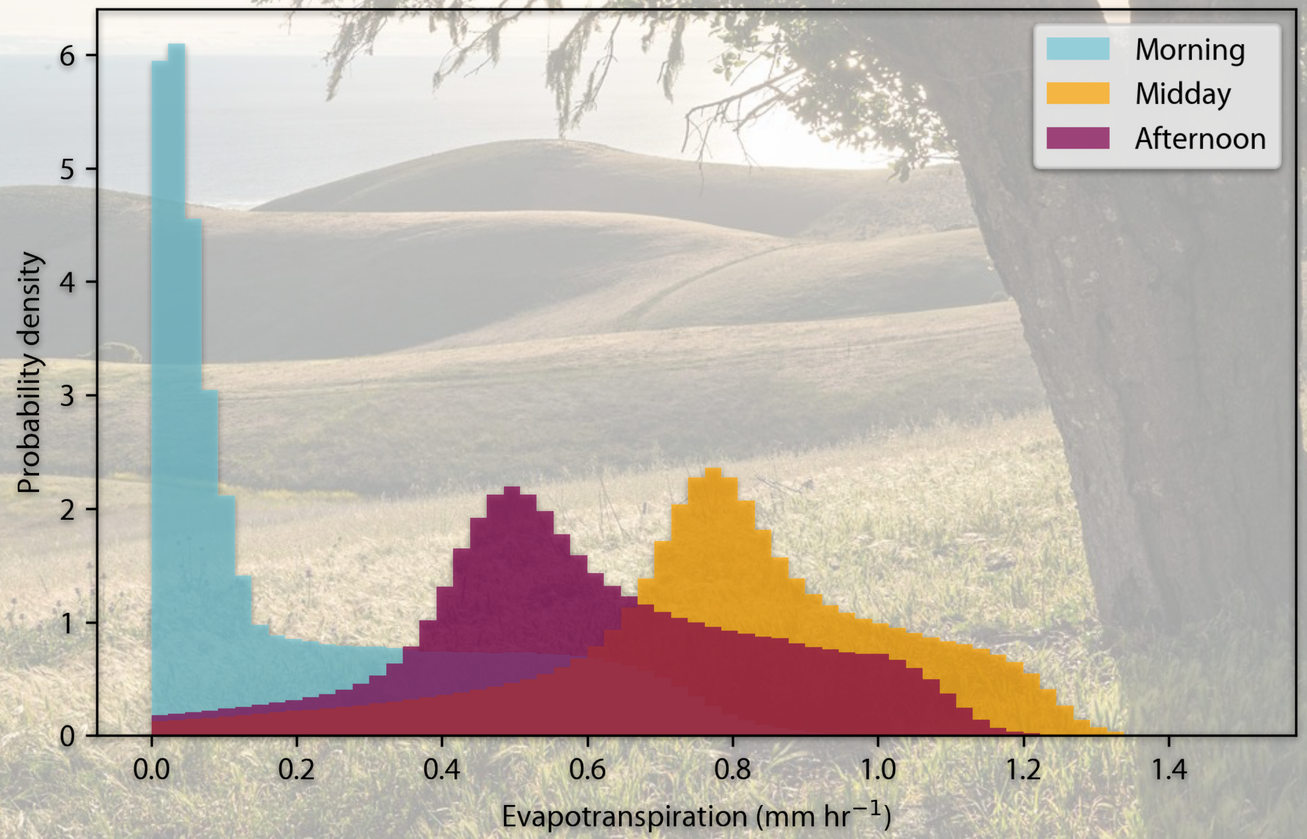




RIPARIAN OAK WOODLAND

Diurnal water use by riparian oaks reflects afternoon down-regulation of photosynthesis.






IMPLICATIONS
How much water is this tree using?
How are these trees—and this landscape—responding to drought?
Which of these trees are experiencing water stress?

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