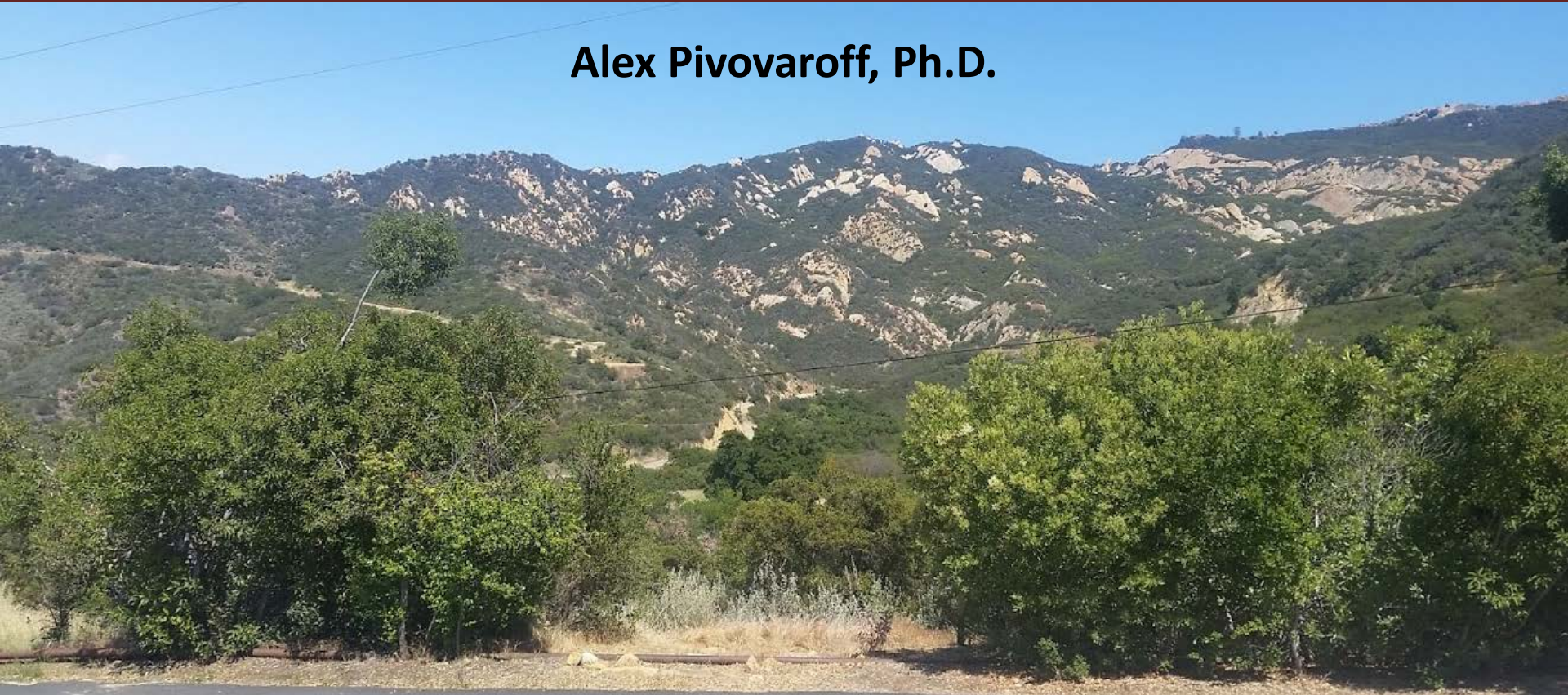
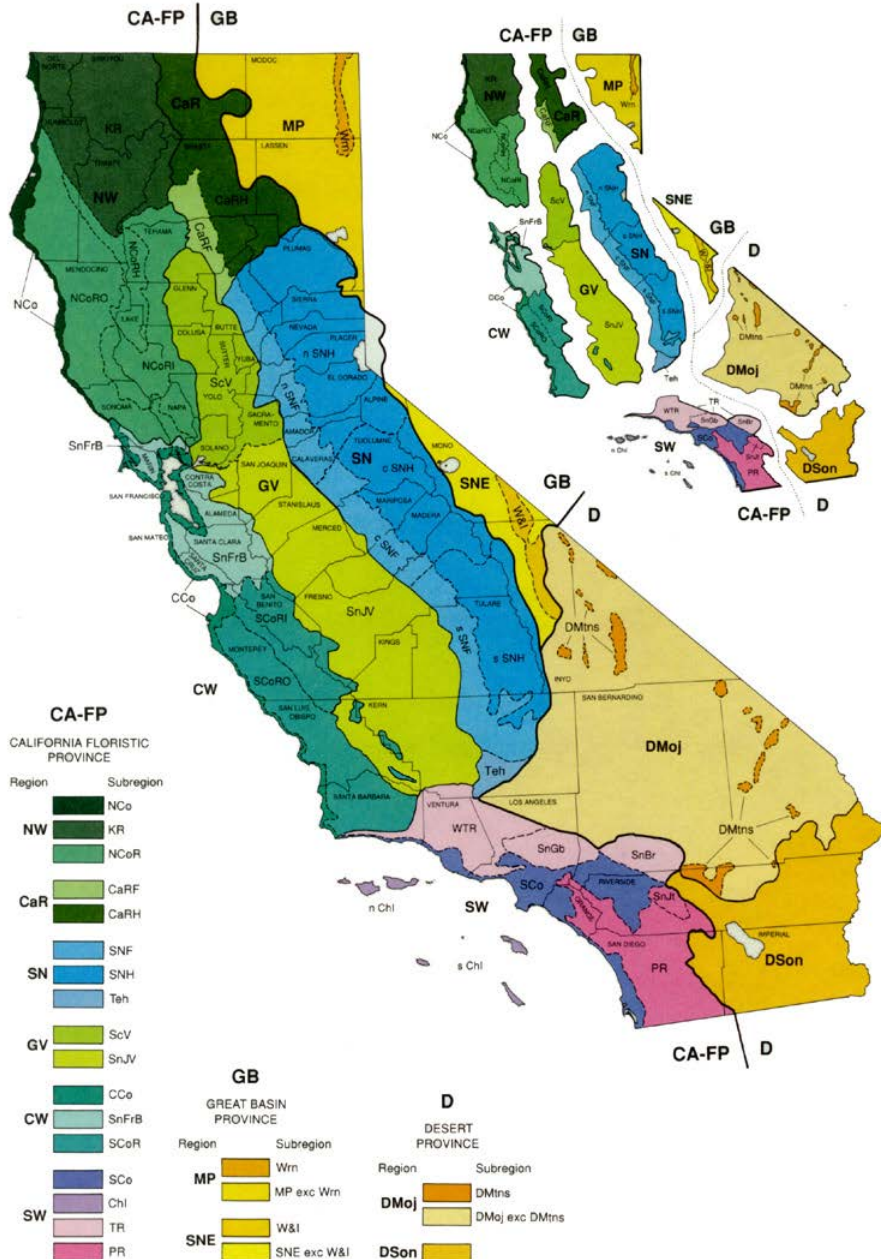


# Chaparral response to heat waves: Extreme heat reduces the carbon gain of chaparral shrubs

**Alex Pivovarovoff, Ph.D.**



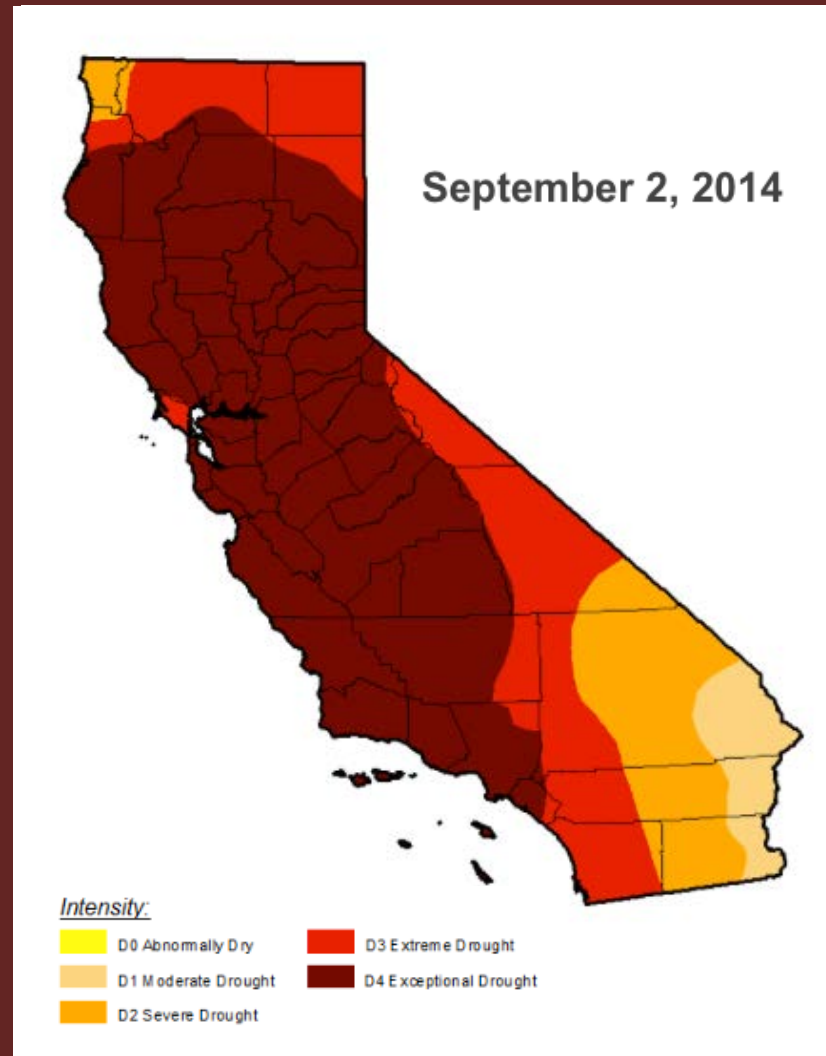
## Geographic Subdivisions of California



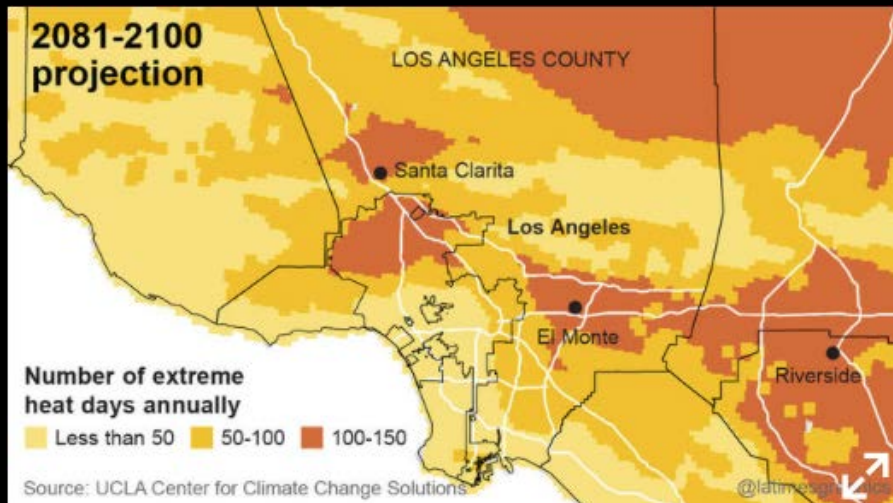
# California is a biodiversity hotspot

- California has a Mediterranean-type climate
- Biodiversity hotspot, conservation priority
- Climate change hotspot (Diffenbaugh *et al.* 2008)

# The 2012-2014 drought was the worst in 1200 years (Griffin & Anchukaitis 2014)



# There will be more heat waves in the future



- “Extreme heat” =  $\geq 35^{\circ}\text{C}$
- Previously = 6 extreme heat days
- Future = 60-90 extreme heat days (Sun et al. 2015)
- New season of extreme heat

# How do chaparral shrubs respond to extreme heat?

$H_o$ :

Chaparral shrubs  
are unaffected

No change in  $CO_2$  fluxes  
No change in  $H_2O$  fluxes

$H_{a1}$ :

Chaparral shrubs  
"shut down"

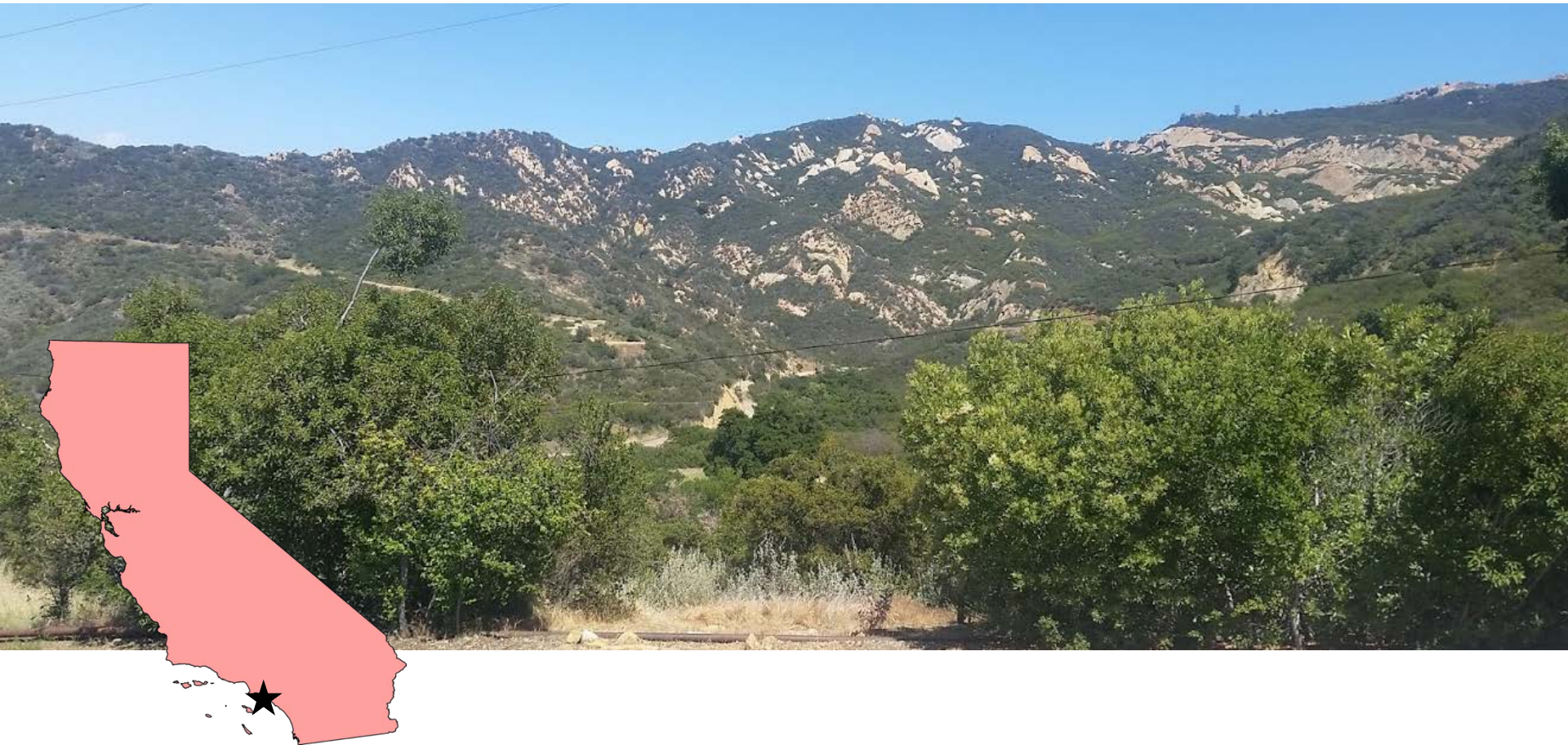
$CO_2$  fluxes decline  
 $H_2O$  fluxes decline

$H_{a2}$ :

Chaparral shrubs  
"sweat"

$H_2O$  fluxes increase

# Field work was conducted at Stunt Ranch, CA, USA



# We installed flow-thru flux chambers on three study species



*Malosma laurina*

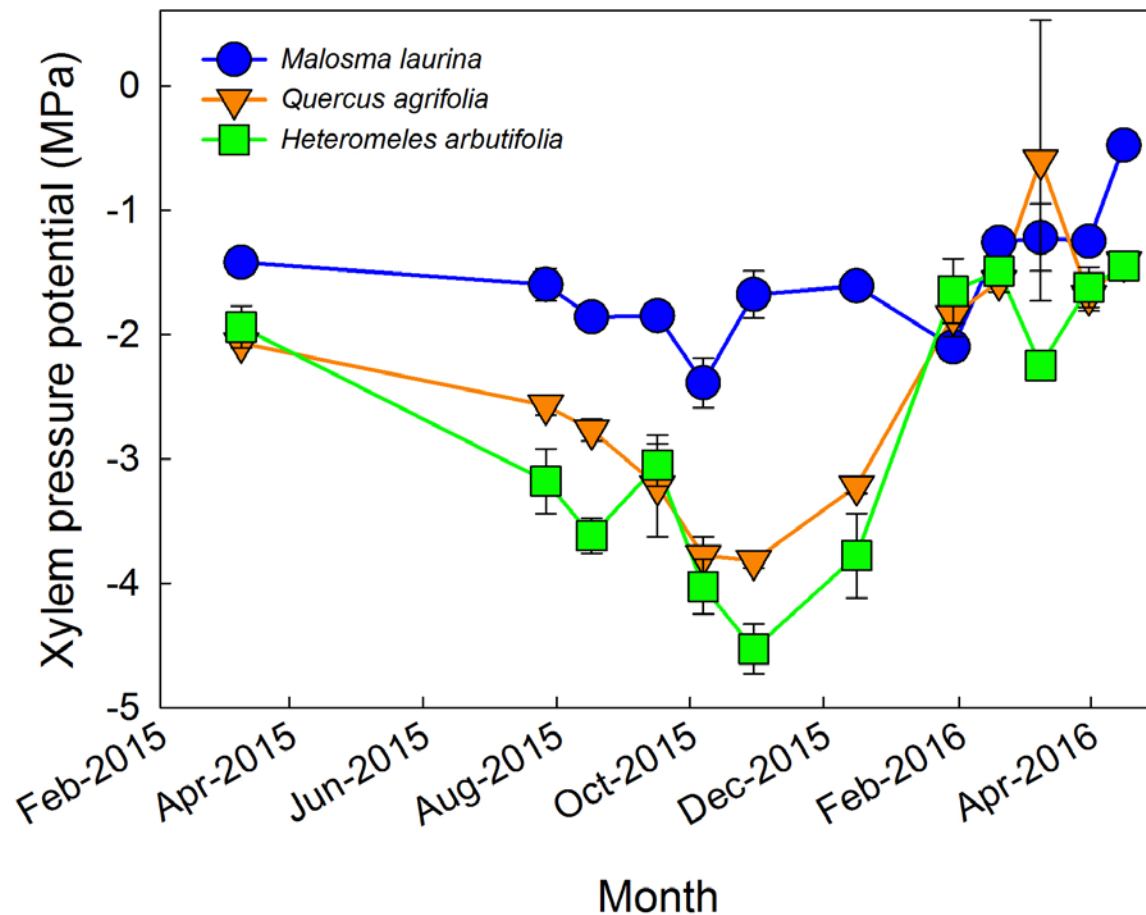


*Quercus agrifolia*



*Heteromeles arbutifolia*

# These study species vary in seasonal water status

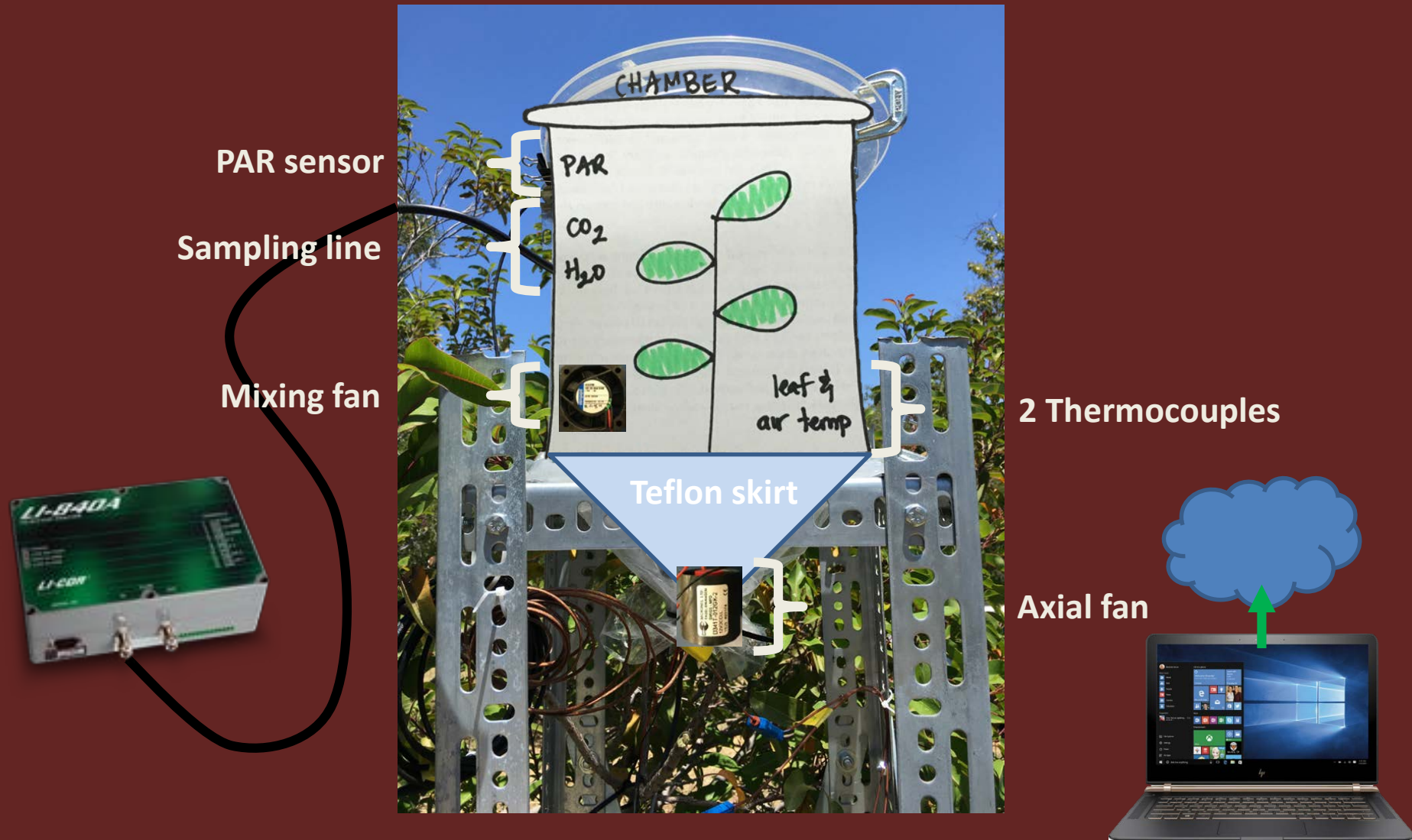




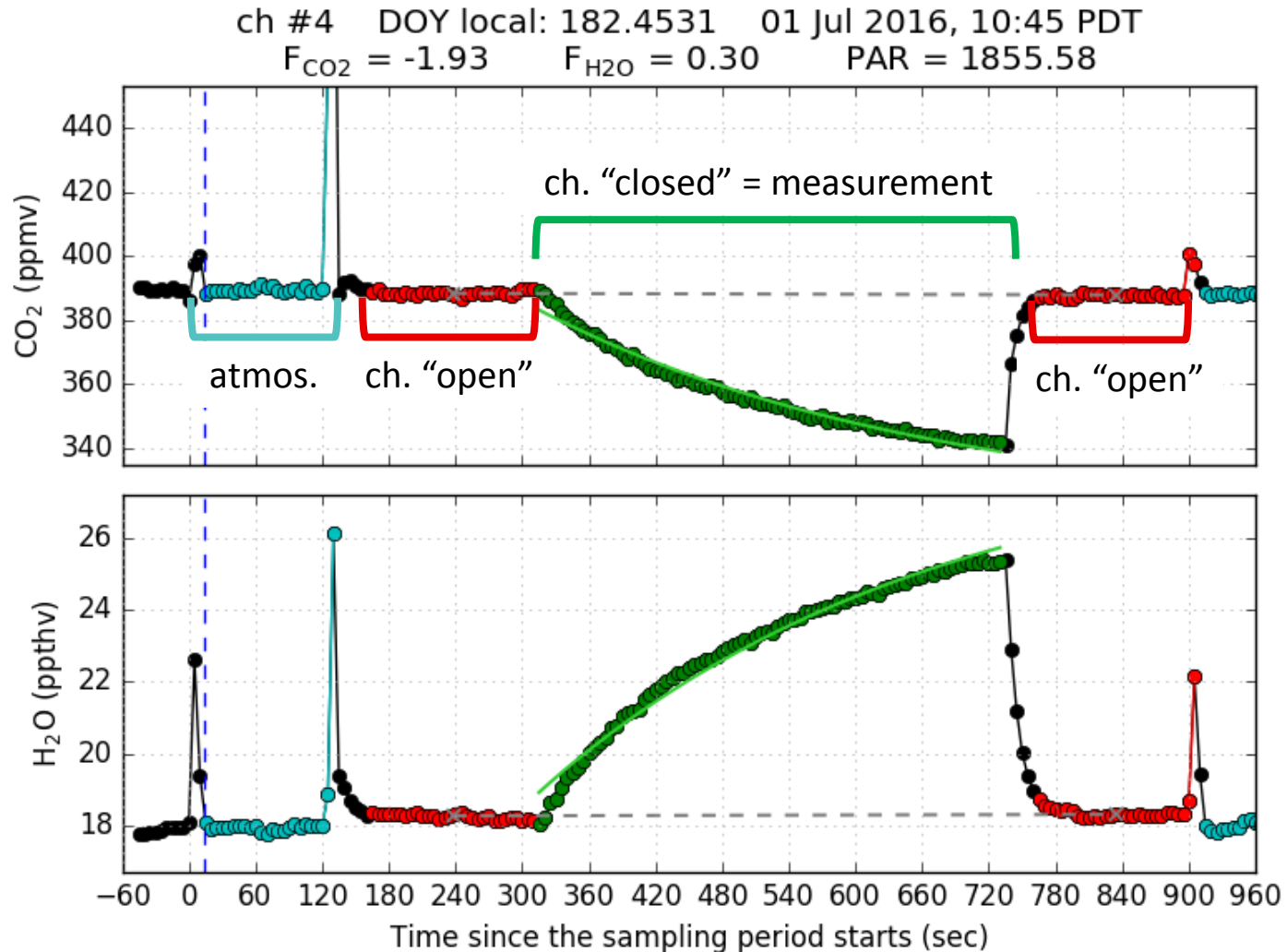
**Flow-thru flux chambers automatically measure CO<sub>2</sub> and H<sub>2</sub>O fluxes and upload the data to the cloud**



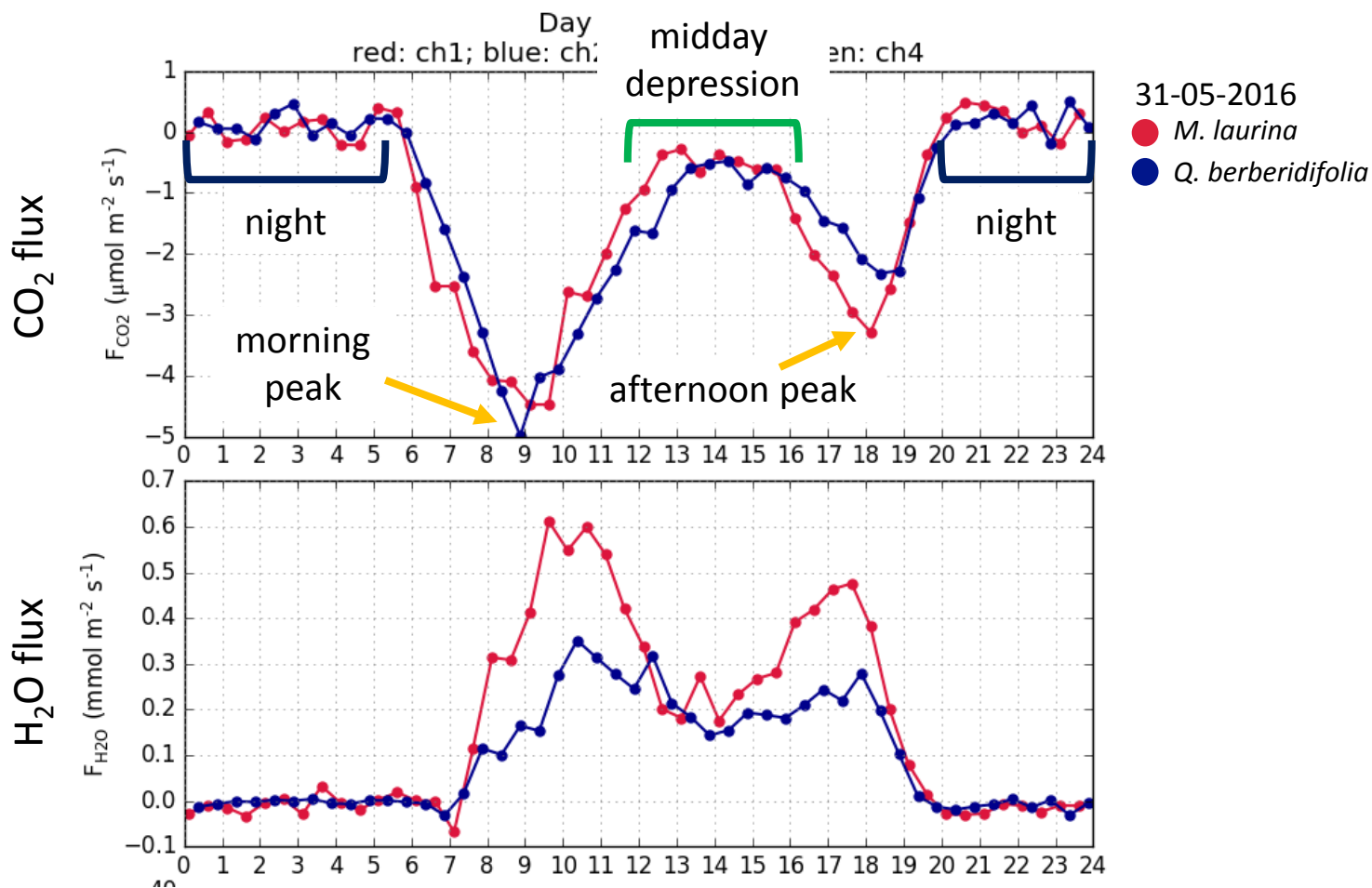
# Flow-thru flux chambers automatically measure CO<sub>2</sub> and H<sub>2</sub>O fluxes and upload the data to the cloud



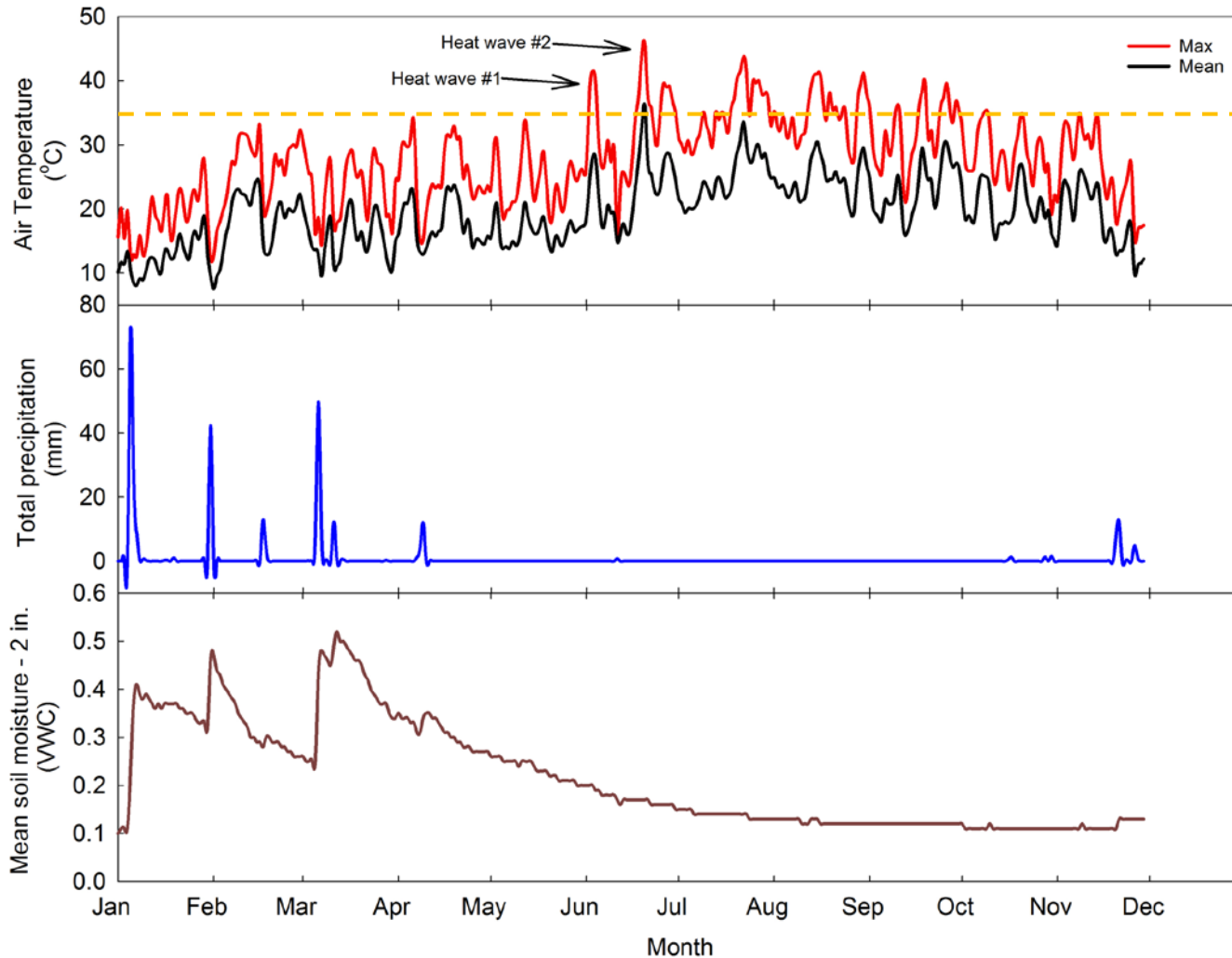
# Example of one measurement cycle



# Example of one diurnal cycle

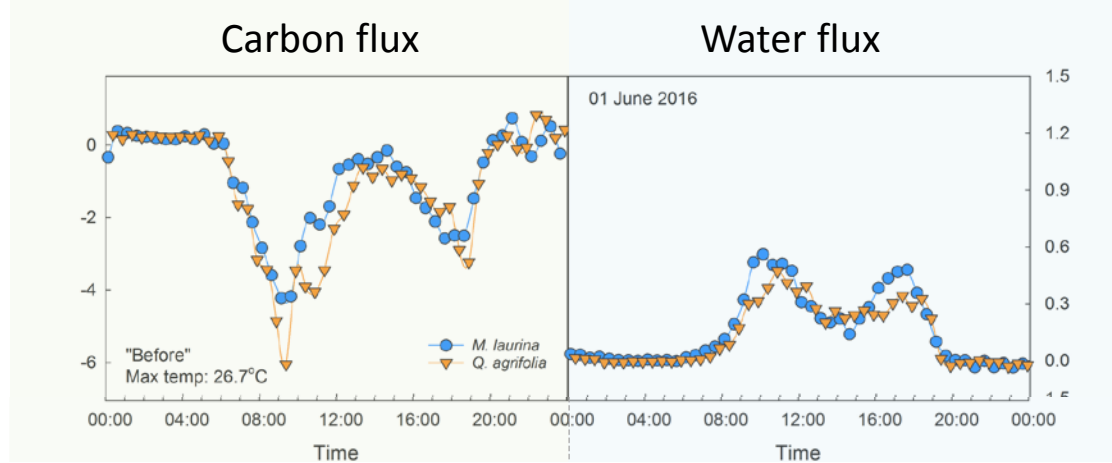


# We will focus on the first heat wave and the hottest heat wave



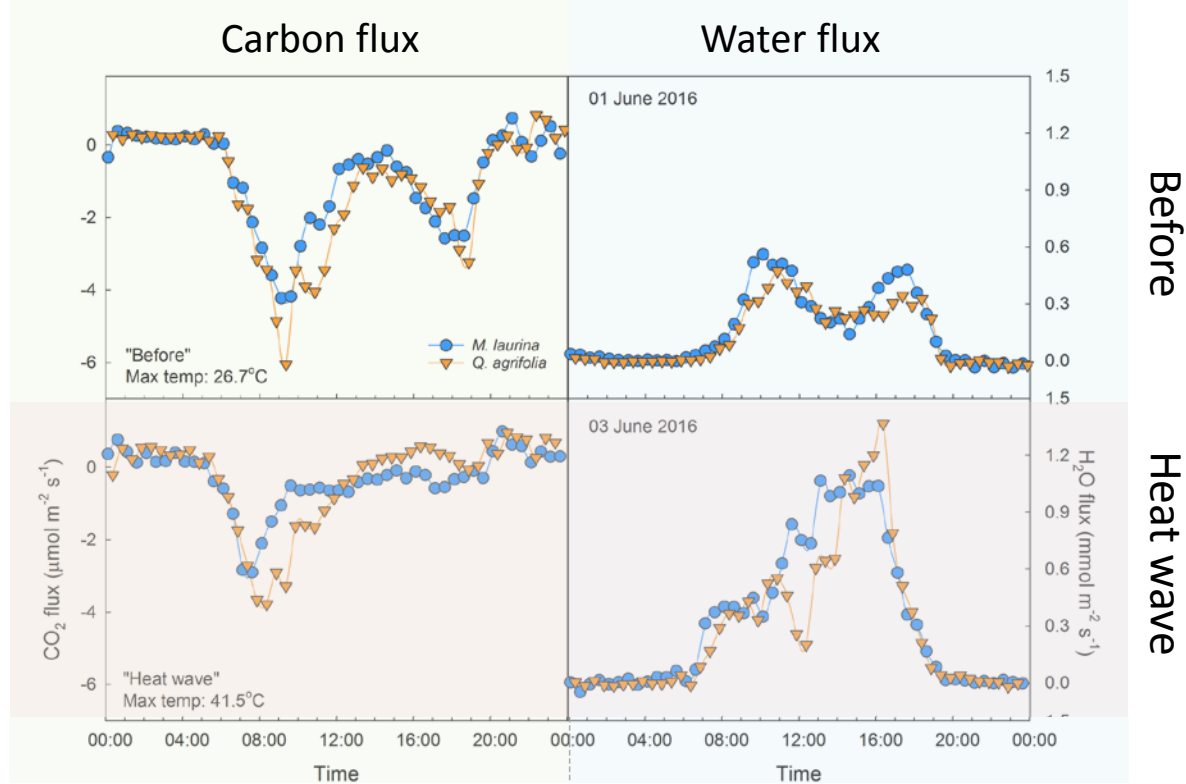
# Results

# During the first heat wave of the year...



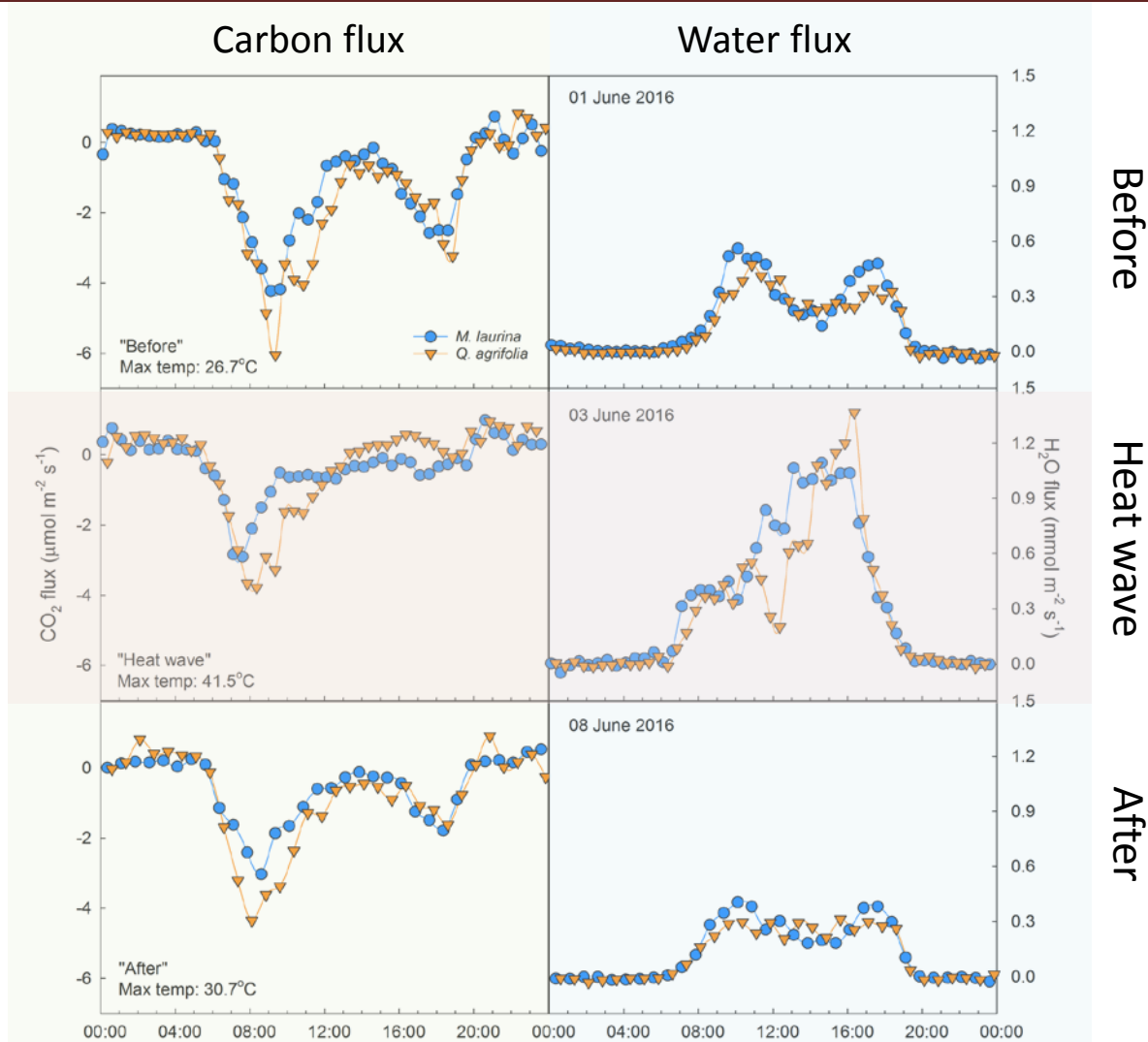
Before

# During the first heat wave of the year...



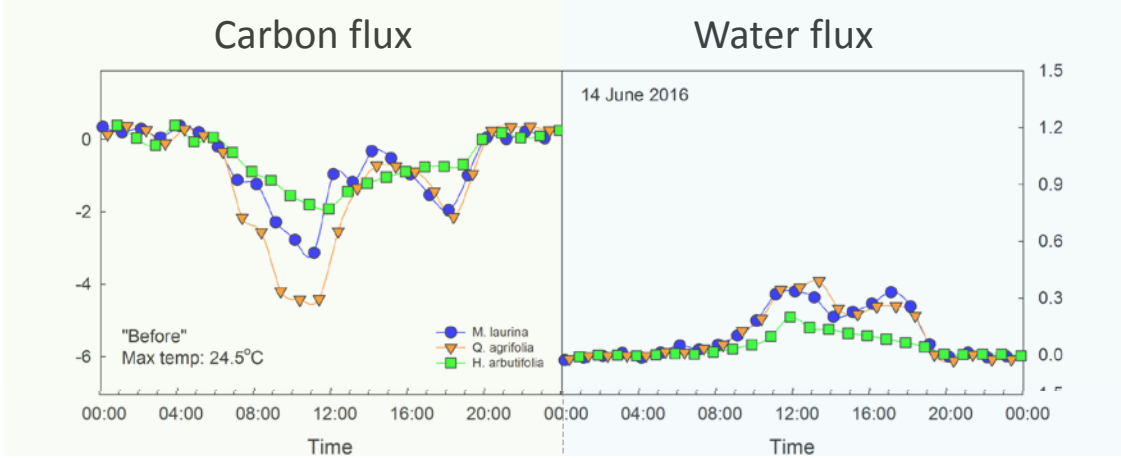


# During the first heat wave of the year...



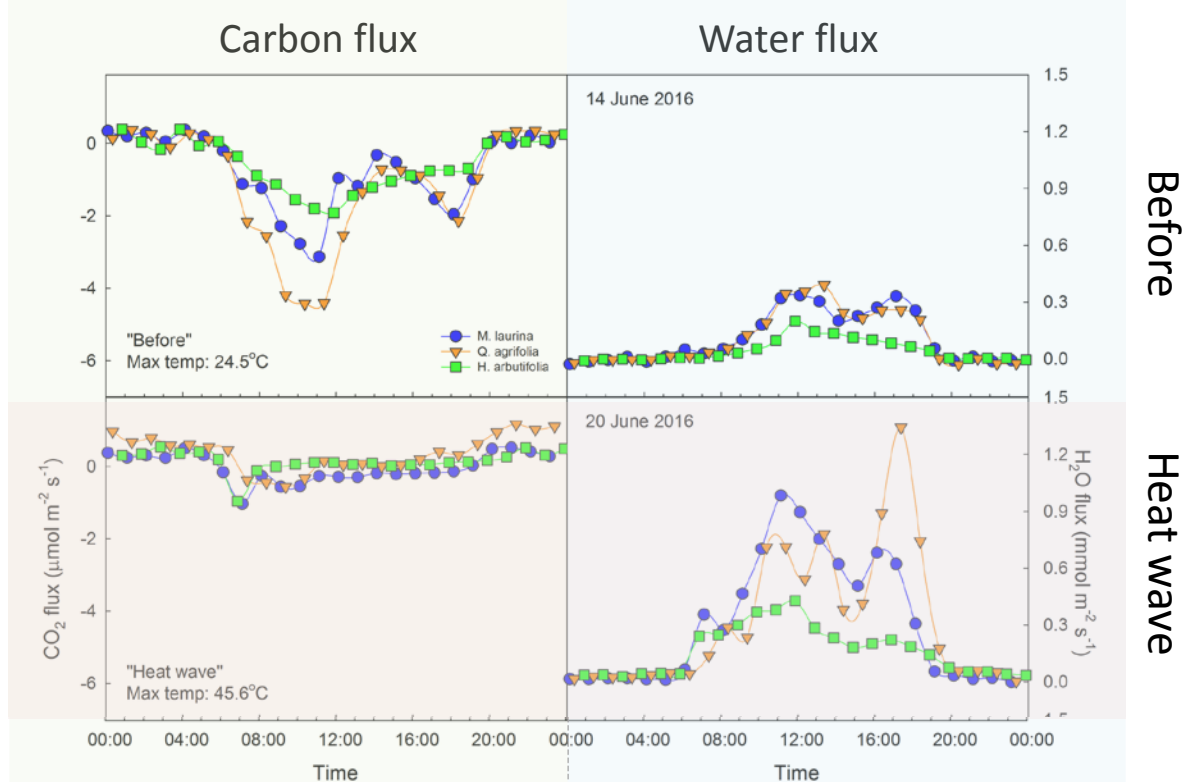
...there was a loss of the afternoon peak, exceptionally high transpiration rates, but recovery once temperatures cooled.

# During the hottest heat wave of the year...

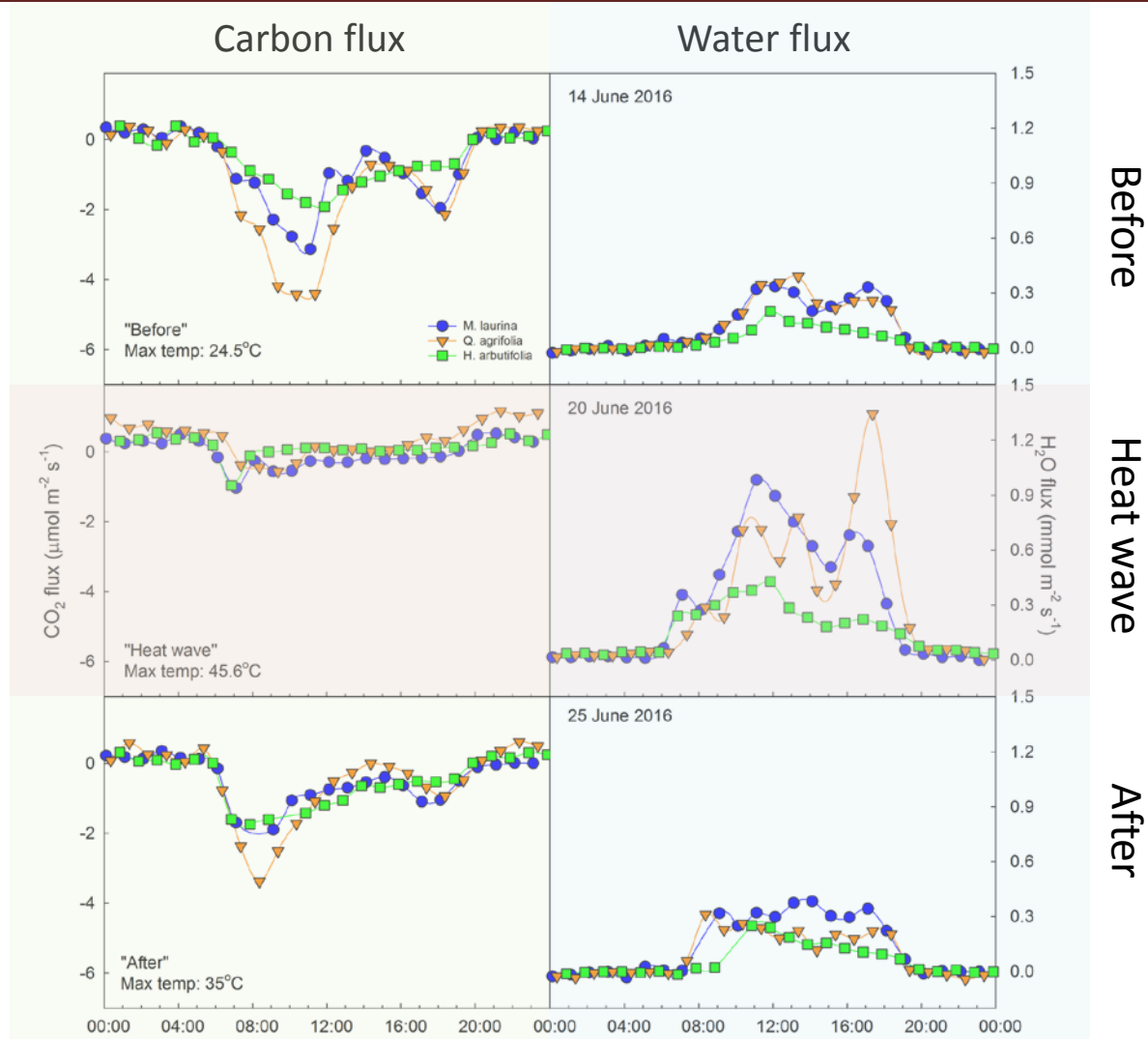


Before

# During the hottest heat wave of the year...

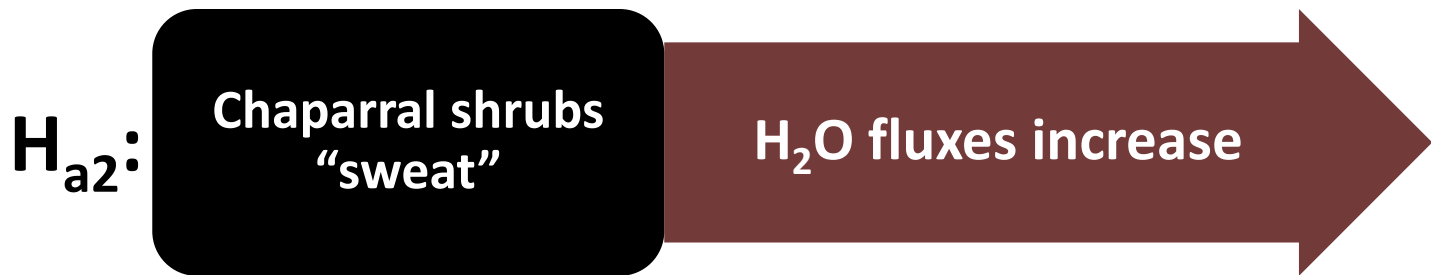


# During the hottest heat wave of the year...



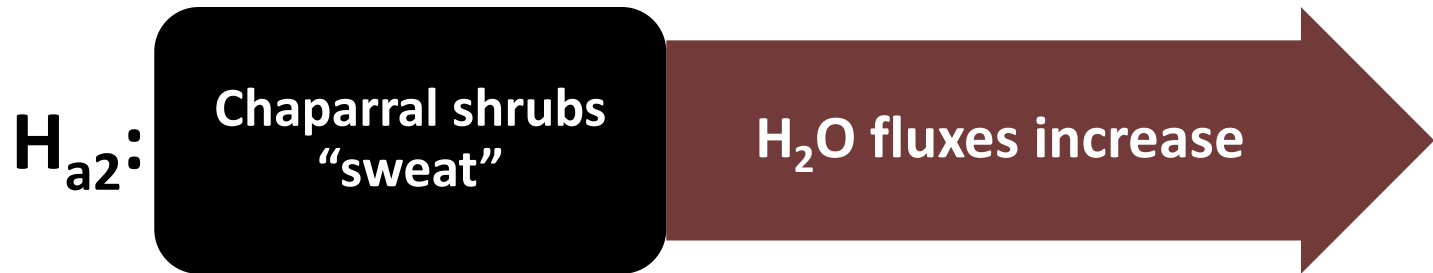
...there was almost no carbon gain, exceptionally high transpiration rates, and diminished recovery.

# Conclusions



- The diurnal pattern featuring a midday depression disappears during heat waves, but recovers quickly after temperatures decline
- Carbon gain is greatly reduced during heat waves
- Latent cooling protects photosynthetic machinery from damage during heat waves
- Recovery is diminished with each successive heat wave

# Implications



- Under a hotter, drier climate:
  - There may not be enough time between extreme heat events to allow for recovery
  - There may not be sufficient water availability to support latent cooling

Wu Sun  
Alejandra  
Pesqueira  
Ulli Seibt



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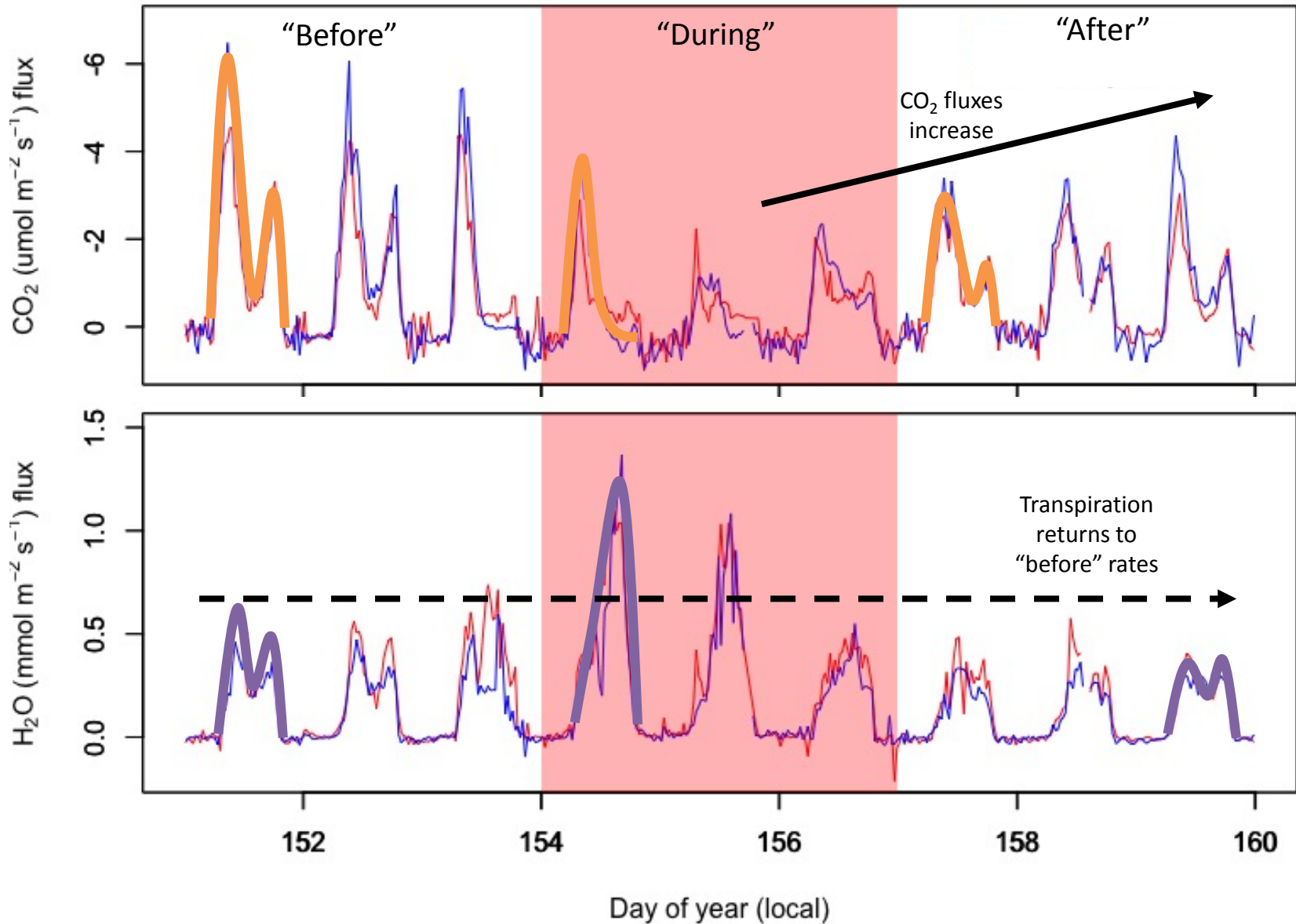


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# Heat waves reduce plant carbon gain, but latent cooling aids quick recovery



# Heat waves reduce plant carbon gain, but latent cooling aids quick recovery

