



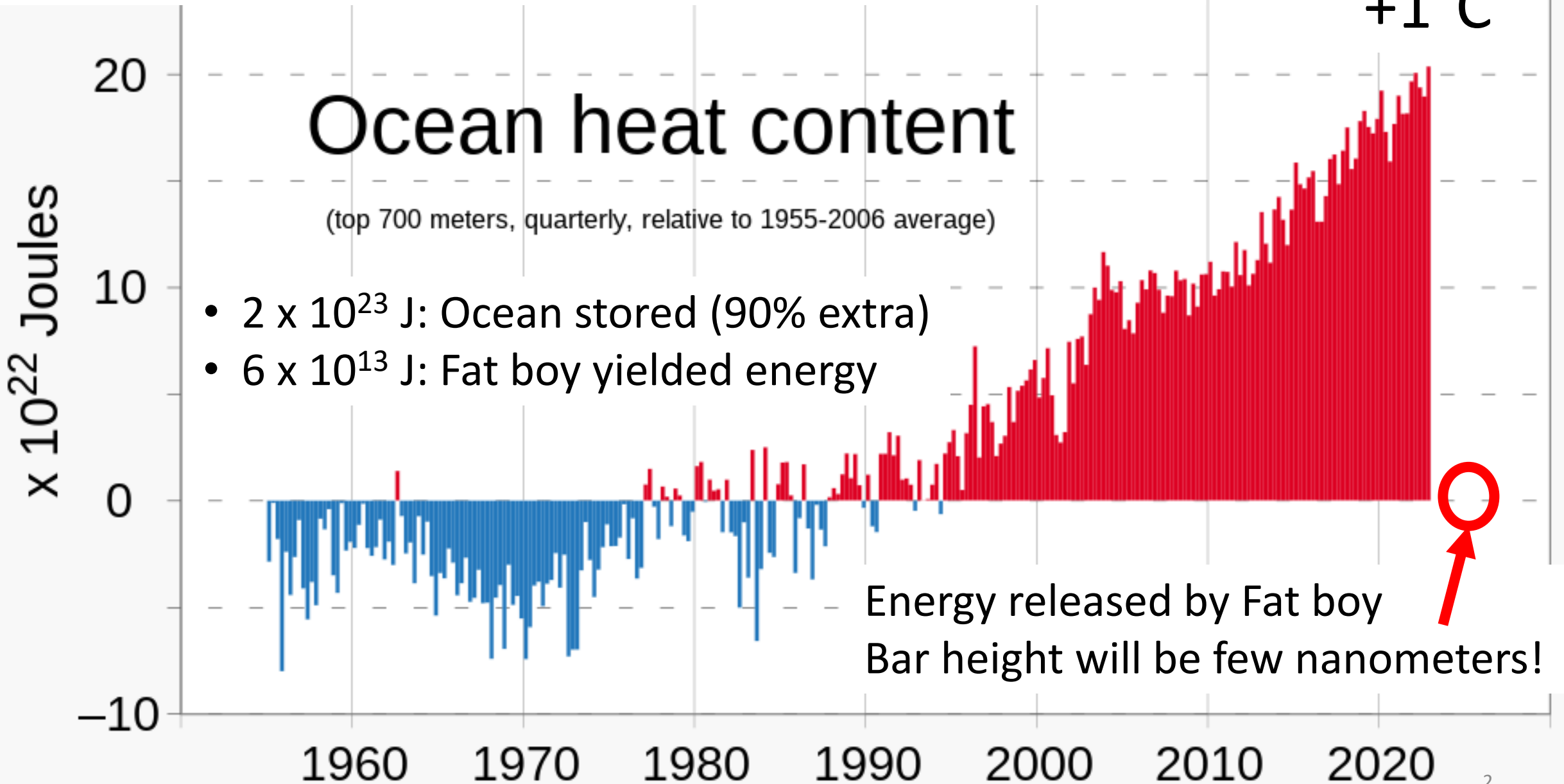
Vineyard Management and Climate Change: Measuring the environment and grapevine stress

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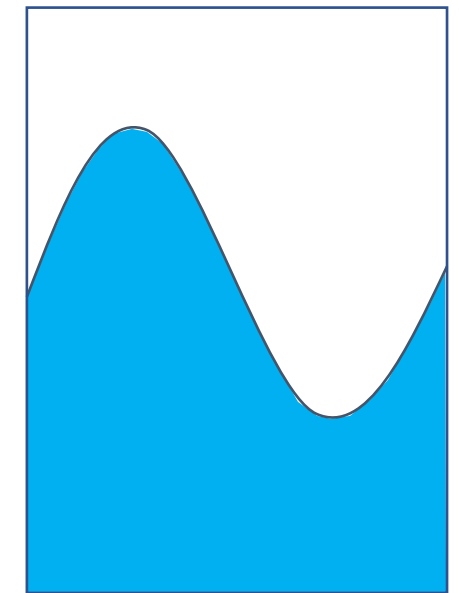
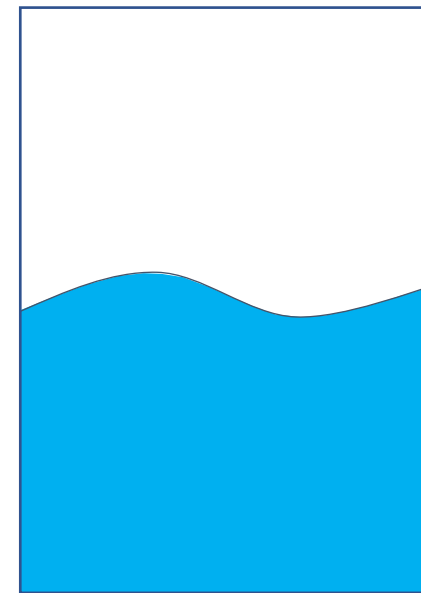
Too much energy trapped on the Earth



Extreme weather: Stronger and more frequent

- Extreme event:
 - Temperature: Hotter and Colder
 - Water: Wetter and Drier
 - Light: Cloudy and Sunny
 - Stronger wind and air stagnation
 - Temporal and spatial changes
- Recent extremes in BC?
 - Extreme cold 2021, 2022
 - Extreme heat 2021
 - Flooding 2021
 - Drought 2022 (West side)
 - Coolest and wet early 2022
 - Warmest late 2022

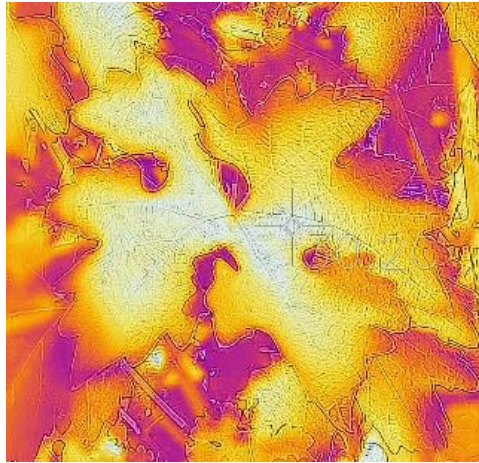
+ 1°C ↗
+ 2 x 10²³ J ↗



Challenge: The kitten (GHG) is still growing!

Climate change and abiotic stress in the vineyard

- Abiotic stress reduces the productivity of grapevines
- Heat stress
 - Reduces photosynthesis
 - Damages berry and leaf cells
 - Affects juice quality
- Drought stress
 - Reduces photosynthesis
 - Reduces yield
 - Might lead to heat stress
- Cold stress
 - Damages tissues
- Hypoxia stress (flooding)



(Photo courtesy of Brian Chen)



Stress management

- What is the stress?
- What is the strength of the stress?
- When and where is the event?
- Are vines sensitive to the stress? (Variety, Phenology, etc.)
- How to mitigate the stress?



- Tolerance
 - Varietal selection
 - Rootstock
- Avoidance
 - Drought stress response
- Mitigate stressors

Drought



Stop
Transpiration

Irrigation



15 mins

Back to work!



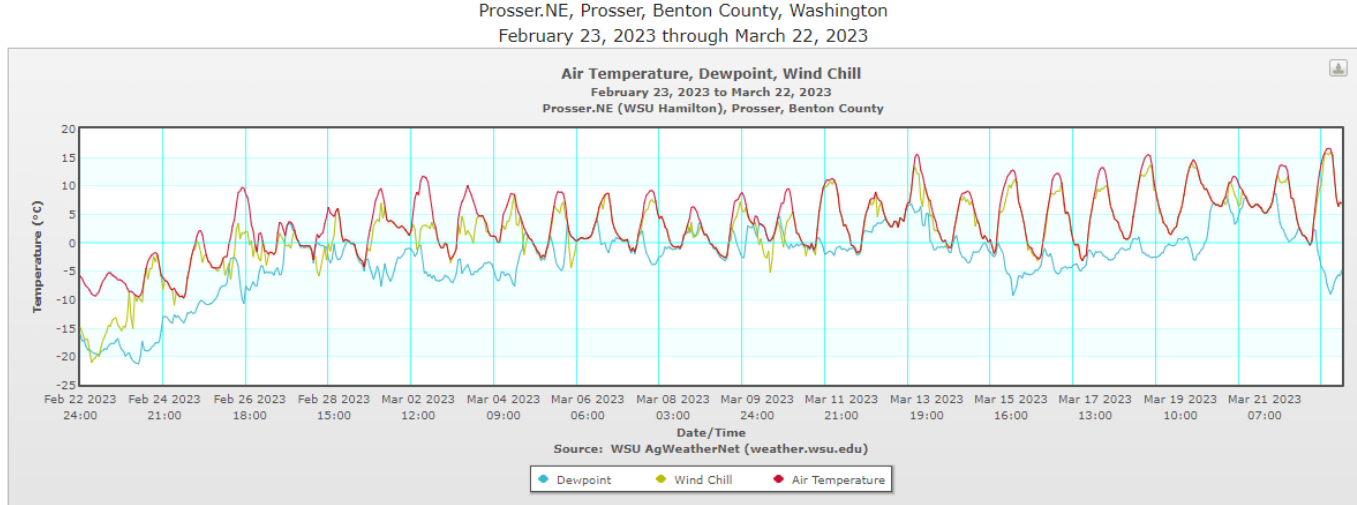
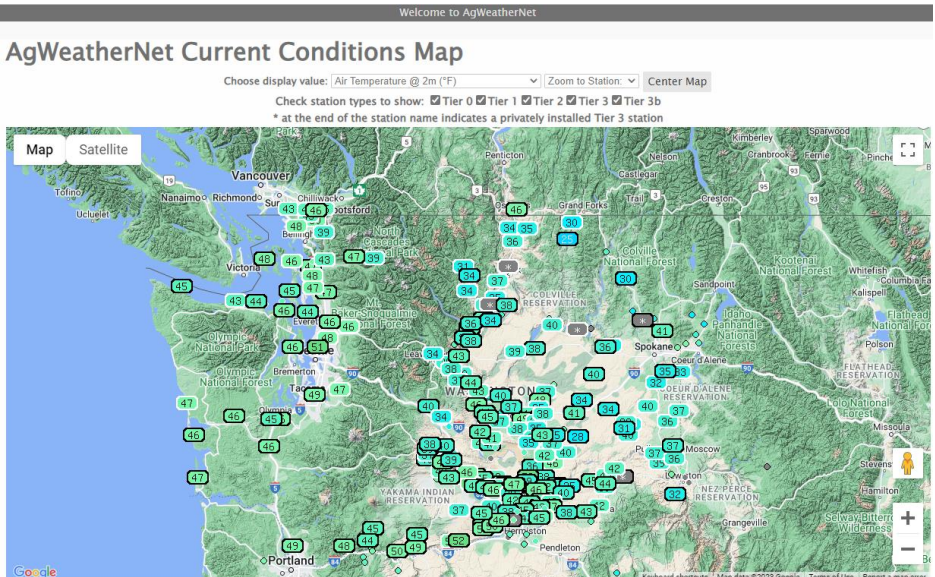
Measuring the environment

- We are bad at sensing the world!
 - Skin measures energy flow not temperature
 - Metal vs Styrofoam
 - Pupil regulates incoming light too well
 - Indoor vs Outdoor
 - We are away from the vines
 - 24/7 in the vineyard? No, thanks.
- Environmental variables
 - Air temperature
 - Relative humidity
 - Soil temperature and moisture
 - Wind
 - Leaf wetness
 - Rainfall
 - Solar radiation
 - Air pressure



Weather station network

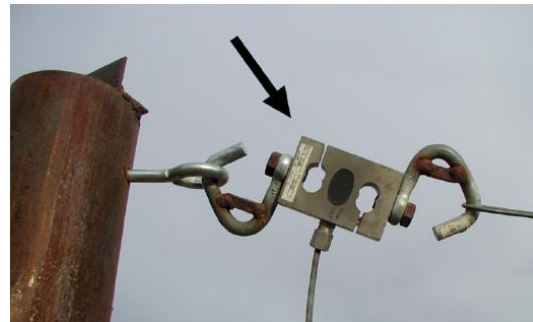
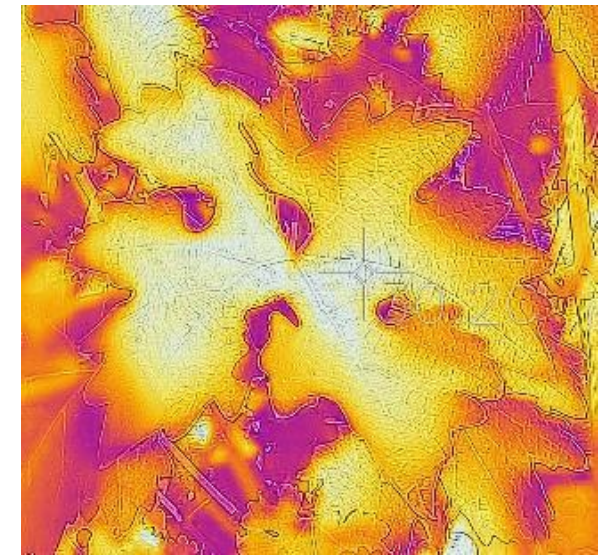
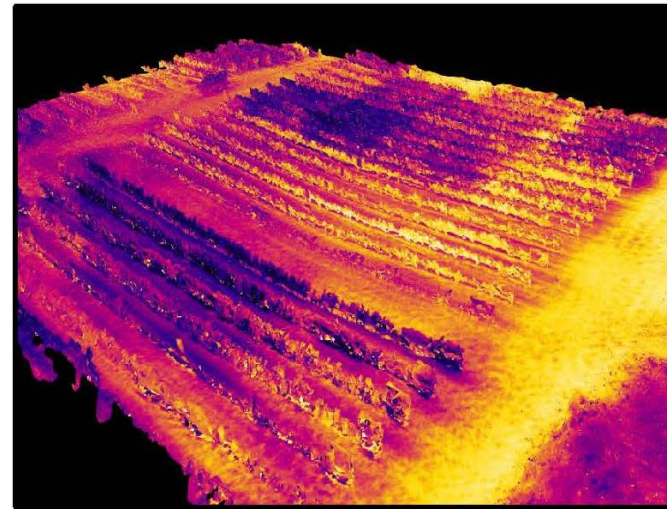
- Standardized measurements
- Data quality control/assurance
- Public access
- Tool platform
 - Models: Cold hardiness, phenology, etc.
 - Spring frost warning



(AgWeatherNet)

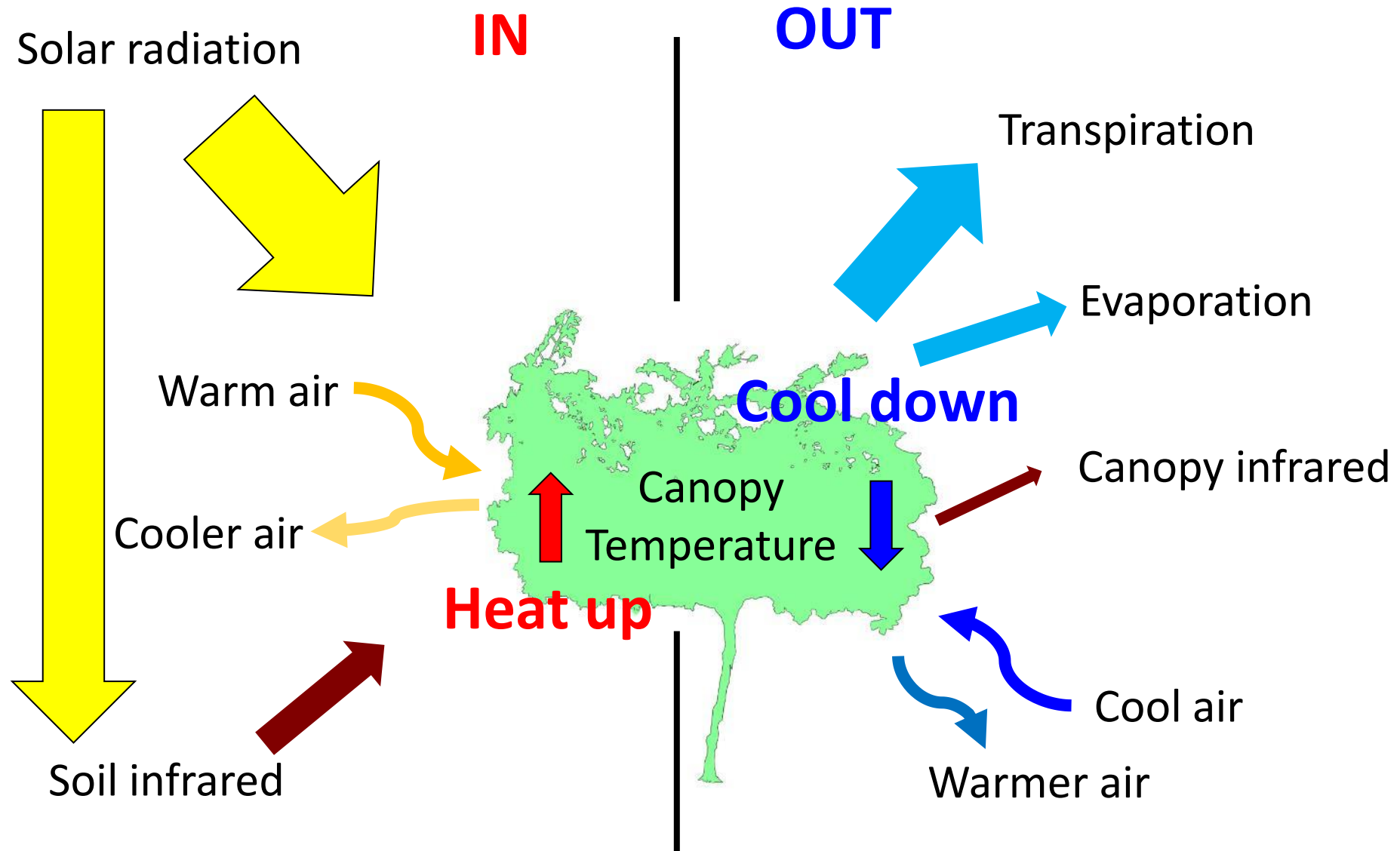
Measuring the stress

- Observations
- Temperature
 - Vineyard
 - Canopy
 - Berry
 - Trunk
- Water stress
 - Canopy temp
 - Pressure bomb
 - Automatic sensor (Microtensiometer)
- Growth
 - Shoot length
 - Berry diameter
 - Trellis tension



Heat stress management

How does heat accumulate on vines?



How to mitigate heat stress?

Block

Solar radiation



- Block light
- Block air flow
- Trap heat
- Not flexible
- Expensive

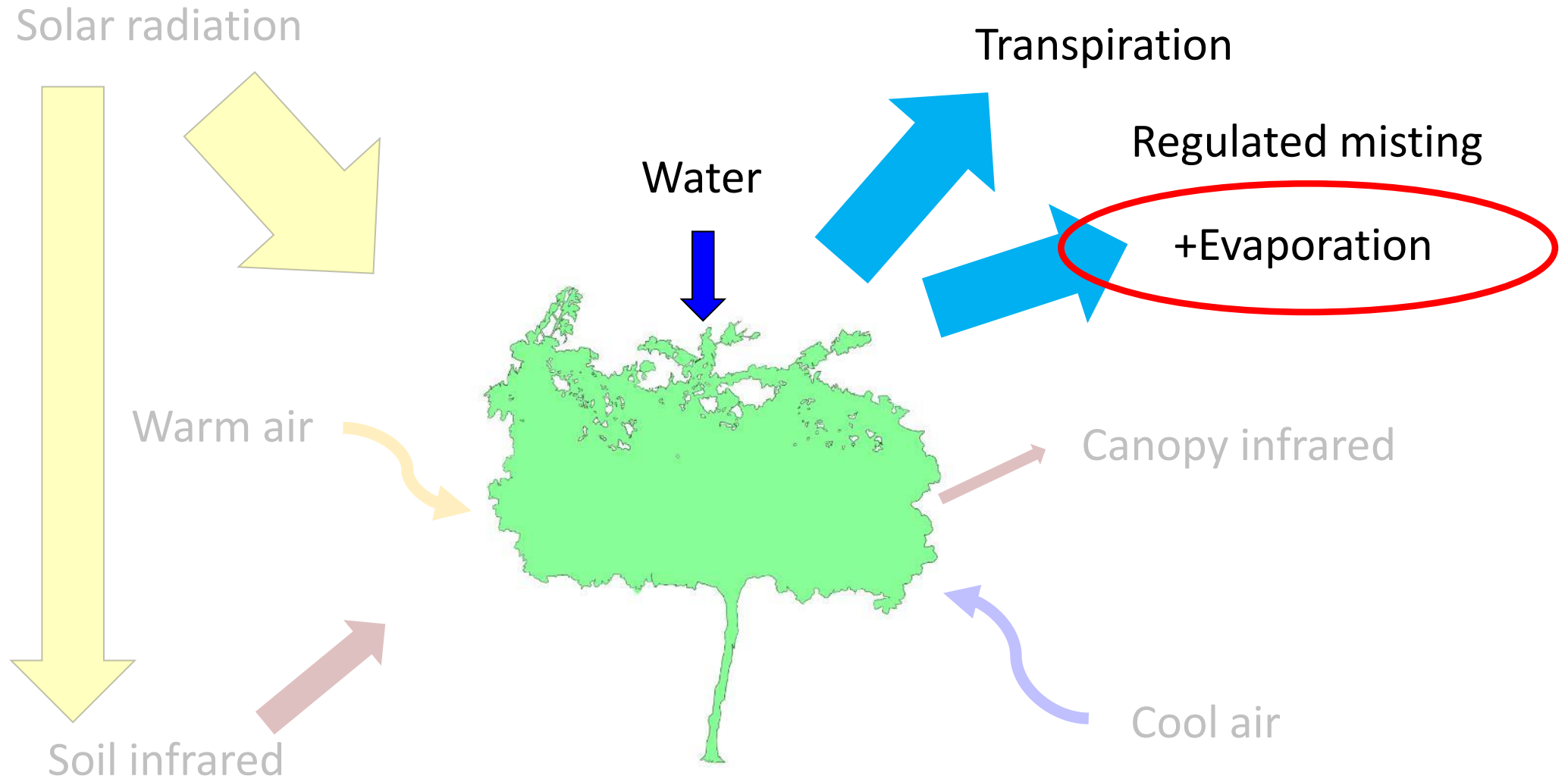
Remove



- How about...
 - RDI? (regulated deficit irrigation)
 - Diseases?
 - Vigor?
 - Berry splitting?

(Photos courtesy of Good Fruit Grower)

Mist-type Evaporative Cooling System (MECS)



- Measure canopy temperature (stressor) directly
- $> 35^{\circ}\text{C}$ will trigger cooling spray
- Leaf wetness sensor
 - No excessive water



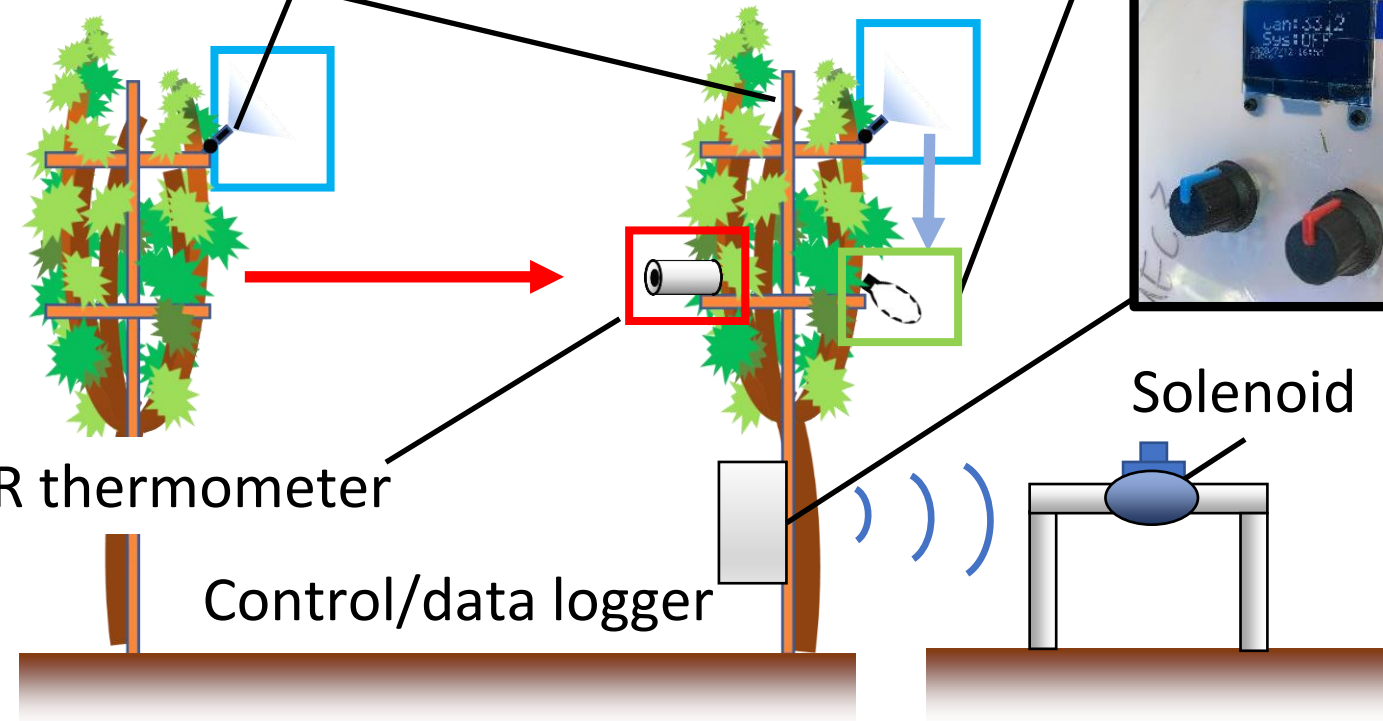
Leaf wetness sensor



Misting nozzle assembly



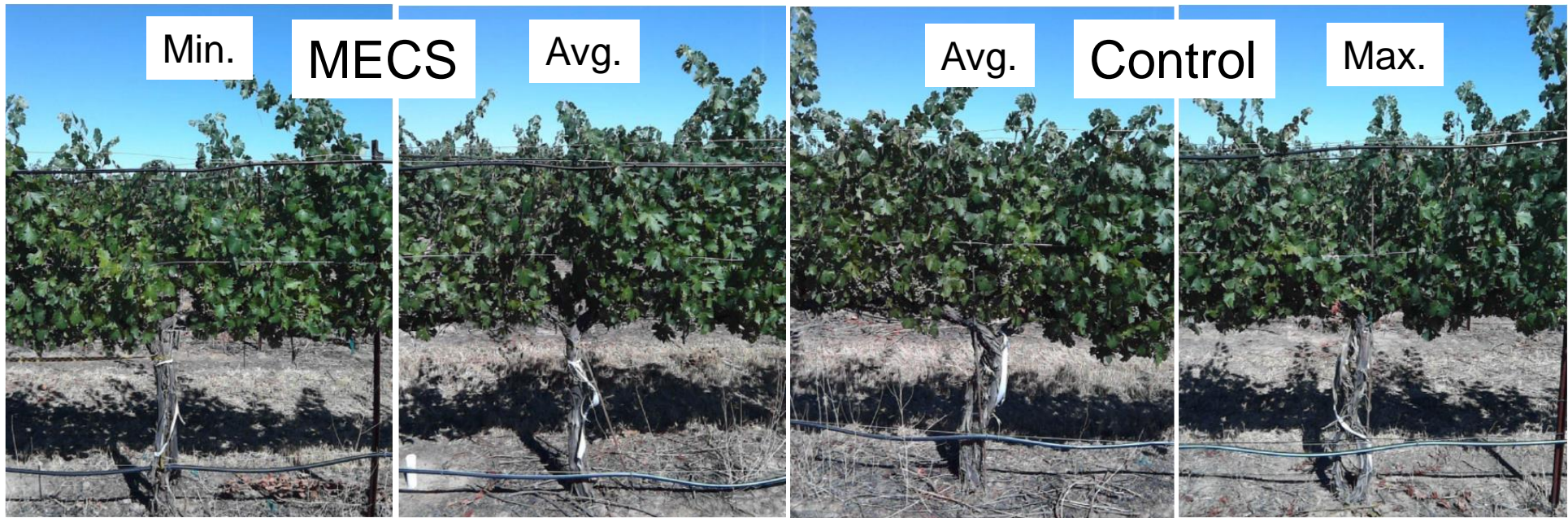
IR thermometer



Solenoid

Control/data logger



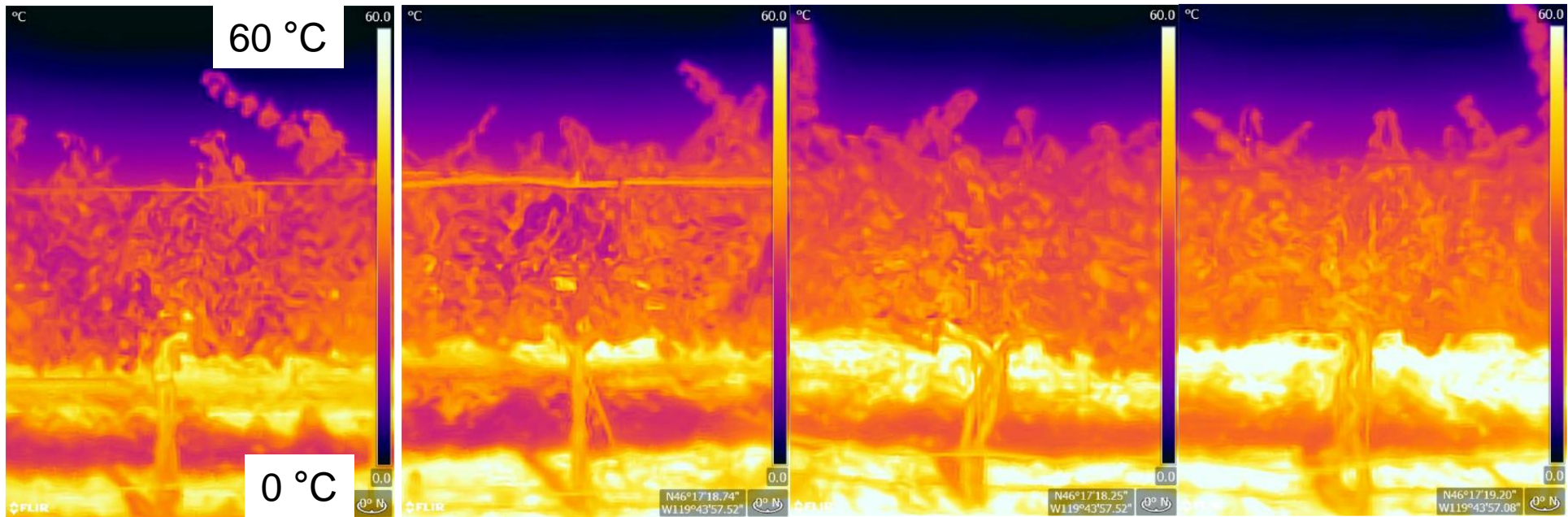


30.6 °C

33.4 °C

35.2 °C

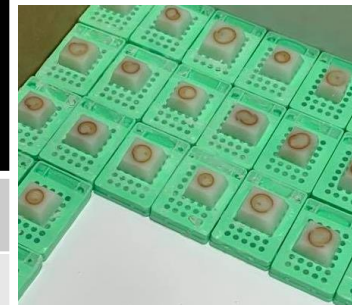
38.1 °C



Berries are larger in the cooled vines (2020)

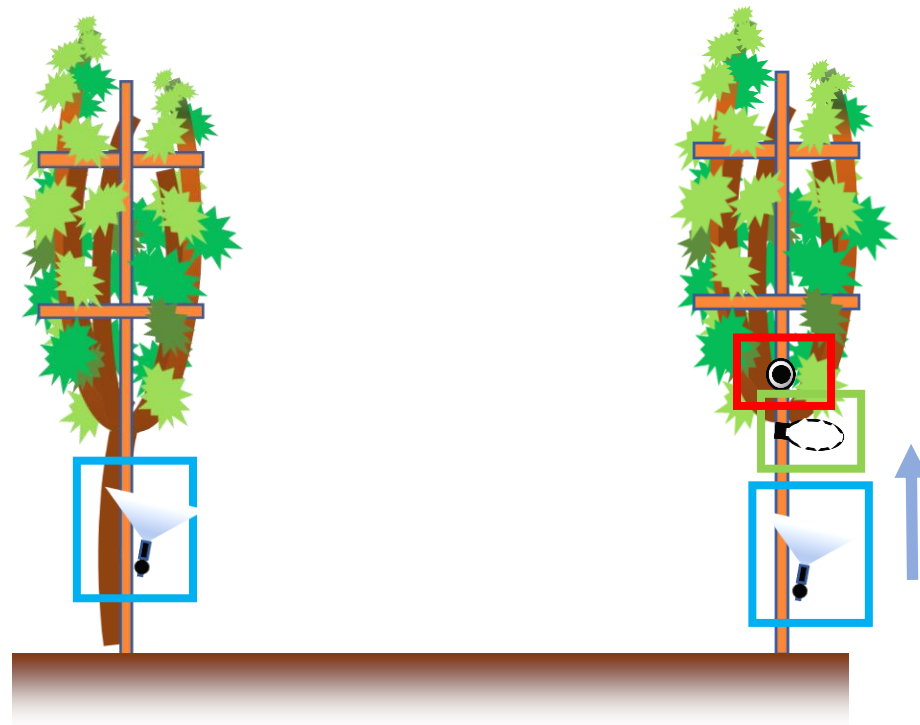
- No significant difference
 - Soil moisture (32 mm consumed)
 - Vegetative and reproductive growth
 - Juice and wine compositions
- Berry sizes, seed numbers and seed weight are different at red/purple stage

	Berry size (g)	Seed number (per berry)	Seed weight (mg)	Cell layers
Control	0.99±0.00	1.60±0.03	14.6±0.3	?
MECS	1.03±0.01	1.85±0.03	16.7±0.3	?



Fruiting zone temperature control (2021, 2022)

- Mitigate heat stress at berries
 - High temperature -> Low TA, High pH
- Could MECS adjust juice/wine composition?
 - Nozzle position
 - Thermometer orientation
 - Leaf wetness sensor position



Parameter	Year	MECS	Control	P-value
TSS (Brix)	2021	26.6 ± 0.2	26.6 ± 0.2	0.42
	2022	25.1 ± 0.2	25.2 ± 0.2	0.77
Titratable acidity (g/L)	2021	8.29 ± 0.22	7.58 ± 0.12	< 0.05
	2022	7.41 ± 0.13	6.31 ± 0.13	< 0.05
pH	2021	2.98 ± 0.00	3.04 ± 0.03	0.18
	2022	3.06 ± 0.01	3.14 ± 0.01	< 0.05
Malic acid (g/L)	2021	3.03 ± 0.18	2.86 ± 0.09	0.38
	2022	1.83 ± 0.02	1.31 ± 0.13	< 0.05
Ammonia (ppm)	2021	100 ± 22	73 ± 9	0.37
	2022	53 ± 3	28 ± 3	< 0.05
PAN (ppm)	2021	50 ± 6	44 ± 3	0.39
	2022	28 ± 1	26 ± 1	0.35
YAN (ppm)	2021	132 ± 24	103 ± 10	0.38
	2022	72 ± 3	49 ± 2	< 0.05

- TA was higher
- Larger berries

- 2021 Cool post-veraison
- 2022 Warmer post-veraison

PAN: Primary Amino Nitrogen
YAN: Yeast Assimilable Nitrogen

Take home messages

- Climate change makes extreme weather and intensifies abiotic stress
- Our sensations are not always reliable
- Monitoring environment and vine stress is critical
 - To evaluate the stress strength
 - To make mitigation decision
- Novel tools are available to assist stress management
 - New sensors
 - Automation

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