

# Napa County Groundwater Sustainability Agency

## Technical Advisory Group

*Update on Evaluating ET*

May 11, 2023



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Scalmanini**  
Consulting Engineers



# Overview



1. Background and Recap of ET
2. CIMIS in Napa Valley
3. OpenET and Field-Based Sensor Update

This item is informational to provide an update on presentations from October and November 2022.



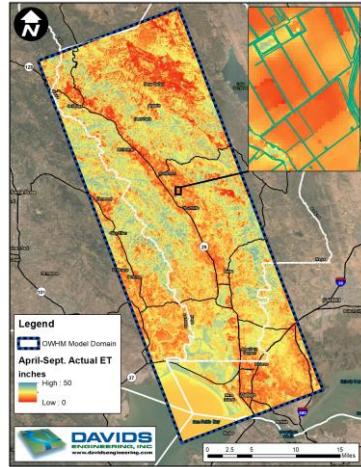
# Background and Recap of ET

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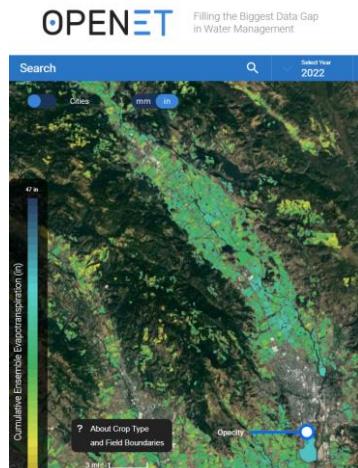


# Timeline of ET Development



**GSP and NVIHM Development:** Napa Valley crop coefficients were developed. These drove groundwater pumping within the NVIHM. Refining pumping estimates via better demand estimates was identified as a key area to improve the NVIHM.

October 2022: Tom Shapland provided an overview of EvapoTranspiration (ET), surface renewal measurements, and variability of Napa Vineyards.



Spring 2023: Began collecting field-level data for ET estimates in Napa Valley and investigating OpenET data.



# Definitions of ET



- Actual ET (ET<sub>a</sub>): Total water use of a crop
- Reference ET (ET<sub>o</sub>): Total water use of a well-watered lawn
  - Published through California Irrigation Management Information System (CIMIS)
- Crop Coefficient (K<sub>c</sub>): Multiplier to go from ET<sub>o</sub> to ET<sub>a</sub> for a well watered crop
- Water Stress (K<sub>s</sub>): Multiplier to go from ET<sub>o</sub> to ET<sub>a</sub> for a deficit irrigated crop

$$ET_a = ET_o * K_c * K_s$$

For modeling and water budget development work, K<sub>c</sub> and K<sub>s</sub> are calculated together for a single crop coefficient.

# Goals of ET Refinements

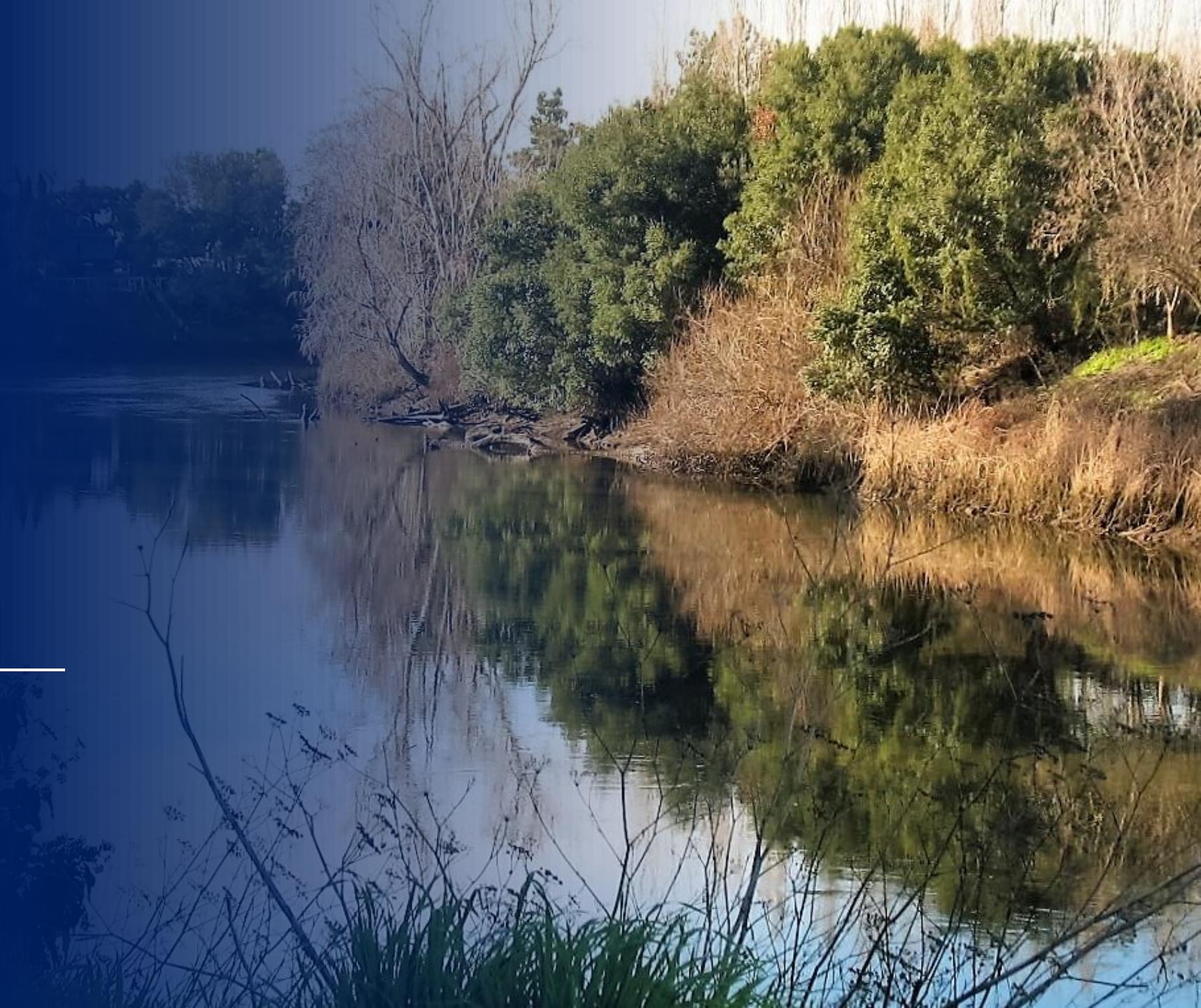


- Refine water budget methodology and estimates.
  1. Through remote sensing be able to capture changes over time.
  2. Have field-scale or sub-region scale crop coefficients.
- Quantify changes in consumptive use based on cultural practices to provide resources for all growers.
  - Trellis class, irrigation type, planting density, rootstock, varietal, etc.



# CIMIS in Napa Valley

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# Oakville CIMIS Station



## Surrounding Criteria:

- Avoid obstructions within 100 yards of the site.
- Avoid abrupt crop/vegetation changes within 50 yards.
- Avoid roads within 50 yards.
- Small rivers no closer than 100 yards, large rivers no closer than 200 yards, lakes no closer than 1,000 yards.



# Potential Other Napa CIMIS Station



- Napa County looking for additional areas for CIMIS stations to be installed across Napa County.
- Looking for County-owned properties, such as golf courses, to agree to house a CIMIS-station.
- Increasing CIMIS stations would:
  - Help refine water balance work.
  - Improve remotely sensed ET estimates.



# Field Measurement and OpenET

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# Outreach Activities

- Outreach for field-based ET measurements lead by RCD.
- Four participants have agreed to provide data with a total of 14 sensors.
- We will continue looking for volunteers across the County.
- Additional measurement types, including metered application, soil moisture, or sap flow measurements will help to refine total water use estimates.



**NAPA VALLEY VINEYARDS: PROMOTING WATER CONSERVATION AND SUSTAINABILITY**

### Data Request: ET Measurements



**Background**  
In accordance with the 2014 Sustainable Groundwater Management Act, the Napa County Groundwater Sustainability Agency (GSA) submitted the required Napa Valley Subbasin Groundwater Sustainability Plan (GSP) to the California Department of Water Resources (DWR) on January 31, 2022. The Napa County GSA began GSP implementation in January 2022. On January 26, 2023, DWR approved the GSP.

The Napa Valley Integrated Hydrologic Model (NVIHM) was developed during preparation of the GSP to quantify basin-wide water budget components and establish sustainable management criteria. The NVIHM is used to estimate total water use and pumping, including for agriculture, based on estimates of evapotranspiration (ET). The total amount of groundwater used is reported every year to DWR. Total ET estimates, including groundwater use and pumping estimates, are based on previous work that used remotely sensed data from 2014 to develop crop coefficients in the Napa Valley. There are now new tools that can help us refine those original estimates.

**Napa Agriculture**  
Napa Valley vineyards have been consistently using water conservation measures and continue to advance water and soil management practices.

To better understand how vineyards in Napa Valley have and will continue to refine water conservation approaches, we need a better method to measure total water use in the entire Napa Valley.

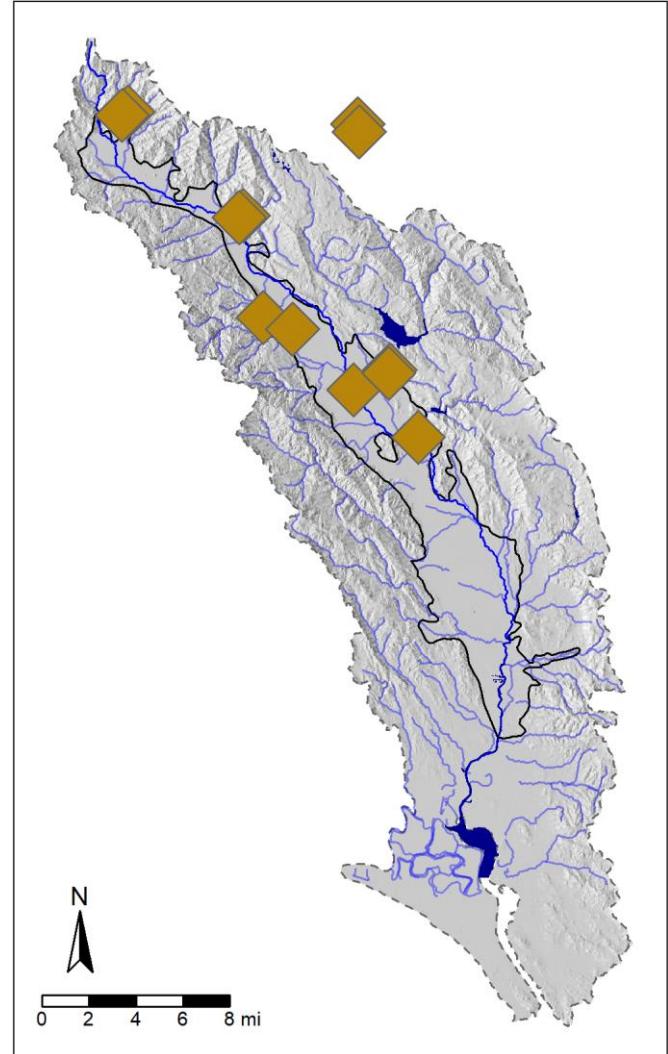
**Data**  
OpenET (<https://openetdata.org>) provides satellite-based estimates of total ET, including ET at a watershed scale. It was developed by a consortium including the Environmental Defense Fund, Google, NASA, Desert Research Institute, USGS, USDA, and more. This method uses various parameters such as surface temperature and reflectance to conduct an energy balance, which results in total ET. There are limitations to using remotely sensed data for any analysis, with a certain amount of error and uncertainty in the data.

As part of ongoing precision agriculture and water conservation efforts in Napa Valley, ET is being monitored on a field-scale in many locations. Tule Technologies is the main provider of field-scale ET. These ground-based sensors are typically Surface Renewal sensors that help monitor total water use, aid in irrigation timing and management, and provide the ability to monitor deficit irrigation. The data from these local sensors can also help validate OpenET data.

# General Map of Sensor Locations



- Good distribution from Oakville and north.
- Some sensors fall outside of the Napa River Watershed, they will be used to evaluate accuracy.
- Varying years of coverage for each sensor.
- Total of ~13,000 field-days of ET measurements.



# Open ET Background



- Landsat imagery (30x30 meter pixel) data are used to look at NDVI, surface temperature, and other variables.
- CIMIS reference ET is used two ways:
  1. Data from CIMIS stations help refine variables measured by Landsat (i.e., solar radiation)
  2. Daily spatial CIMIS is used to extrapolate between satellite overpasses.

Model acronym	Model name
ALEXI/ DisALEXI	Atmosphere-Land Exchange Inverse/ Disaggregation of the Atmosphere-Land Exchange Inverse (ver. 0.0.27)
eeMETRIC	Mapping Evapotranspiration at High Resolution with Internalized Calibration (ver. 0.20.15)
geeSEBAL	Surface Energy Balance Algorithm for Land using Google Earth Engine (ver. 0.2.1)
PT-JPL	Priestley-Taylor Jet Propulsion Laboratory (ver. 0.2.1)
SIMS	Satellite Irrigation Management Support (ver. 0.0.20)
SSEBop	Operational Simplified Surface Energy Balance (ver 0.1.5)

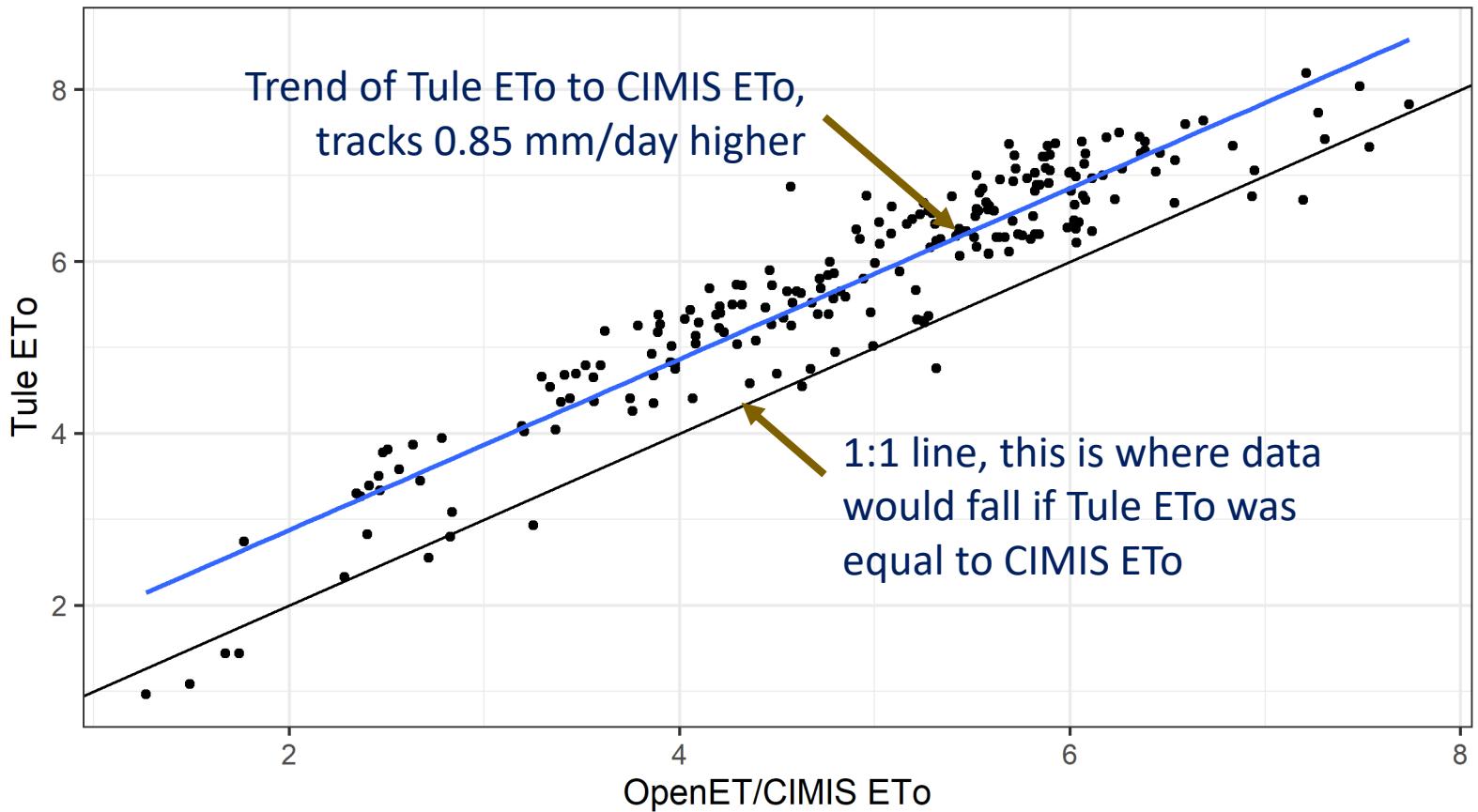
# Reference ET



Tule calculates a proprietary reference ET specific to the field of measurement while OpenET uses spatial-CIMIS.

In general, the Tule ETo is higher than the CIMIS ETo.

Reference ET Comparison WY 2021  
Single Vineyard



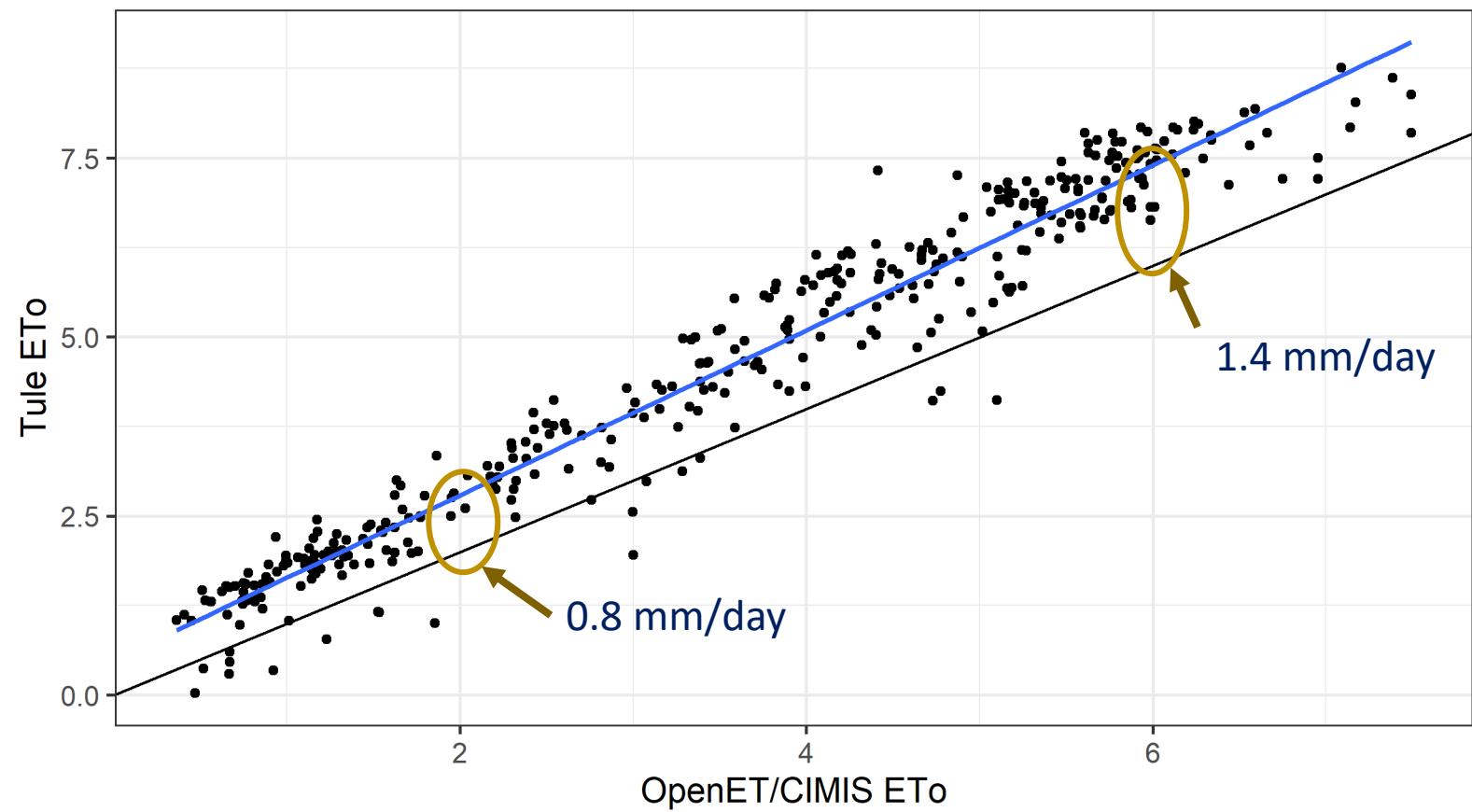
# Reference ET – continued



In general, if CIMIS is currently underestimating ETo in Napa, that would impact total pumping and water use estimates from the NVIHM.

Reference ET Comparison WY 2021

Vineyard B



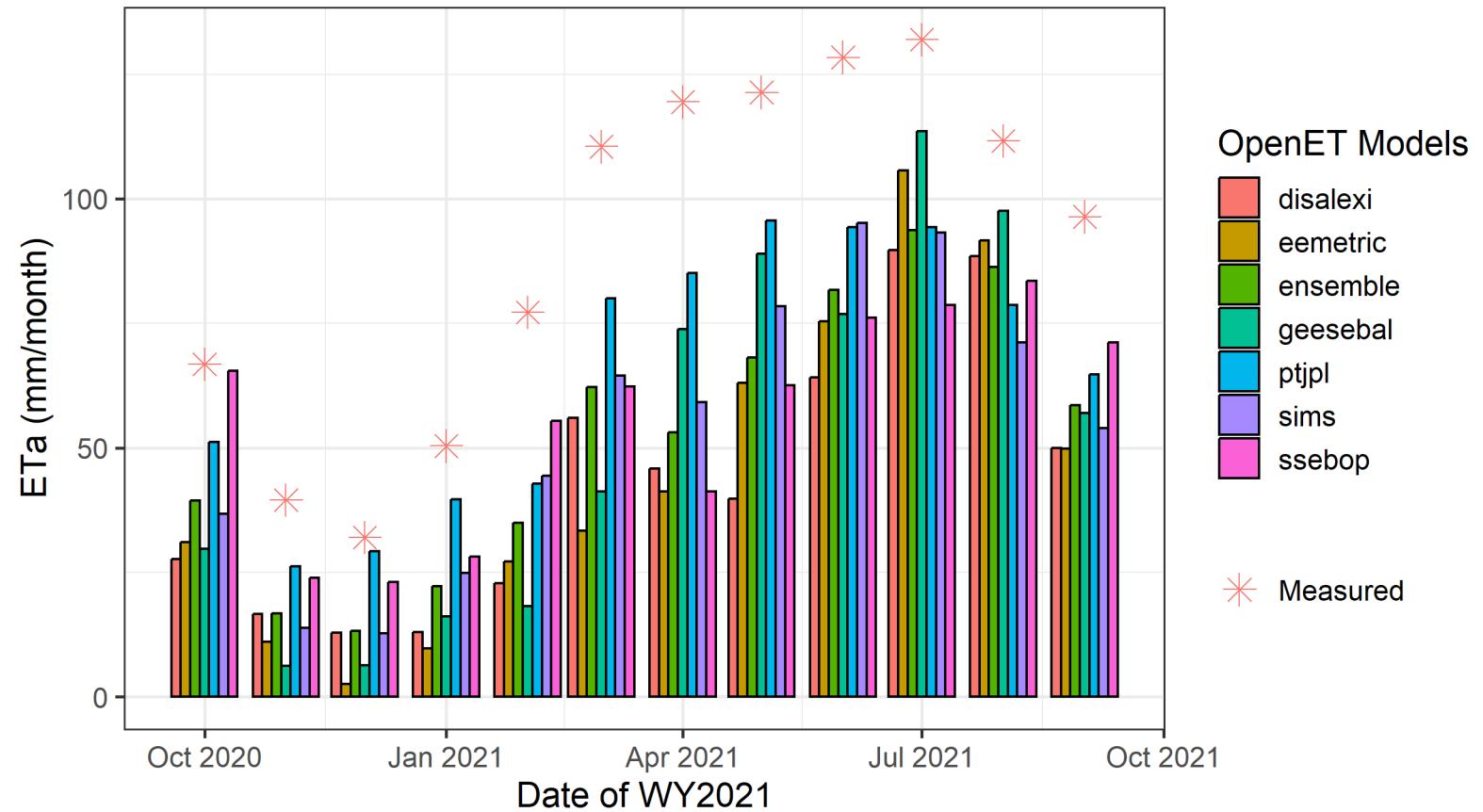
# OpenET and Measured Data – Monthly



When compared to monthly measured data, OpenET shows a bias to underestimate the total ETa.

Systemic differences may be attributable to lower CIMIS ETo data.

OpenET Models for a Single Vineyard in WY 2021  
Monthly ETa

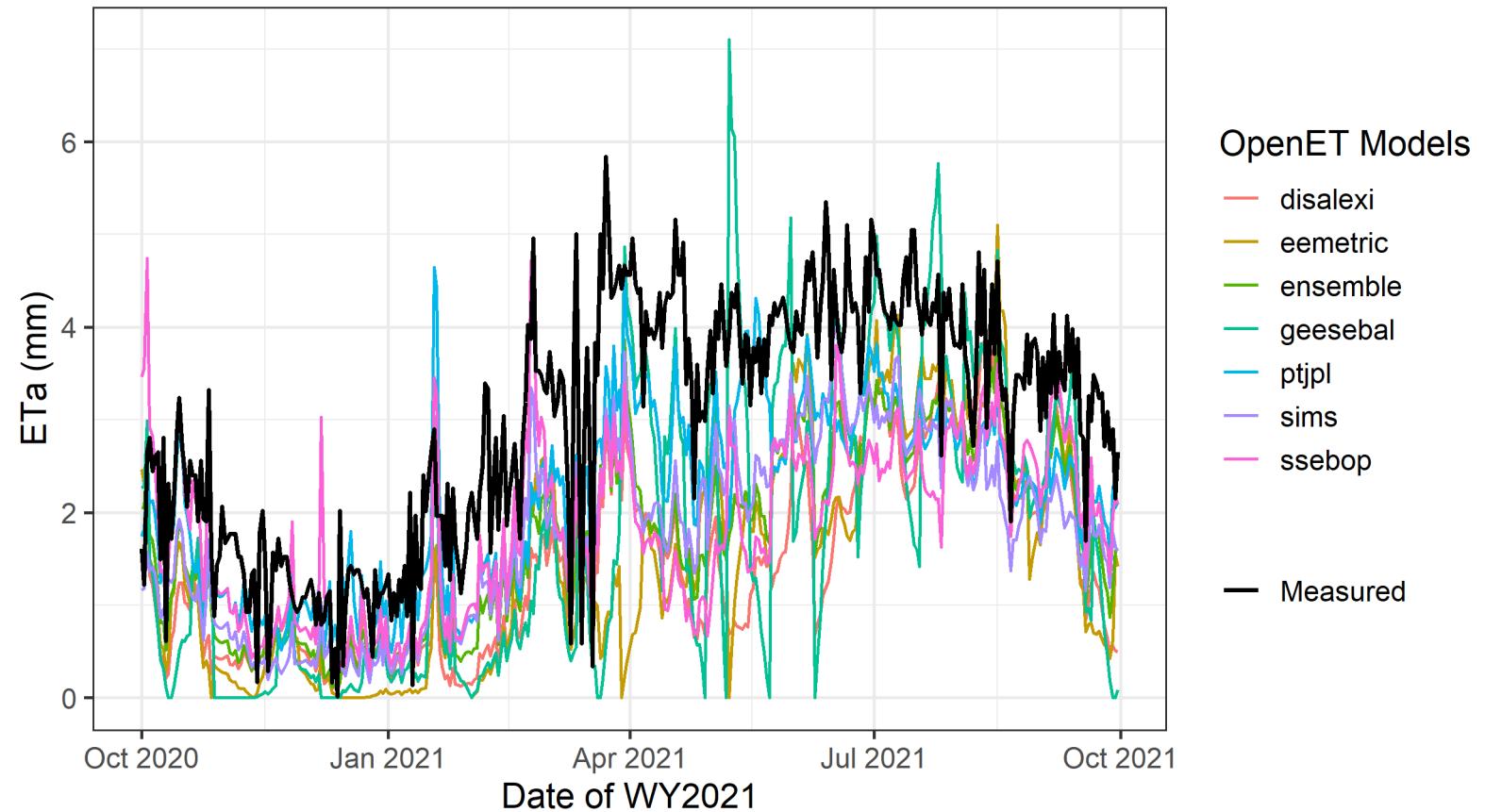


# OpenET and Measured Data



Daily data from Tule (measured) and OpenET sources show no single model captures similar variability as the measured data.

OpenET Models for a Single Vineyard in WY 2021  
Daily ETa

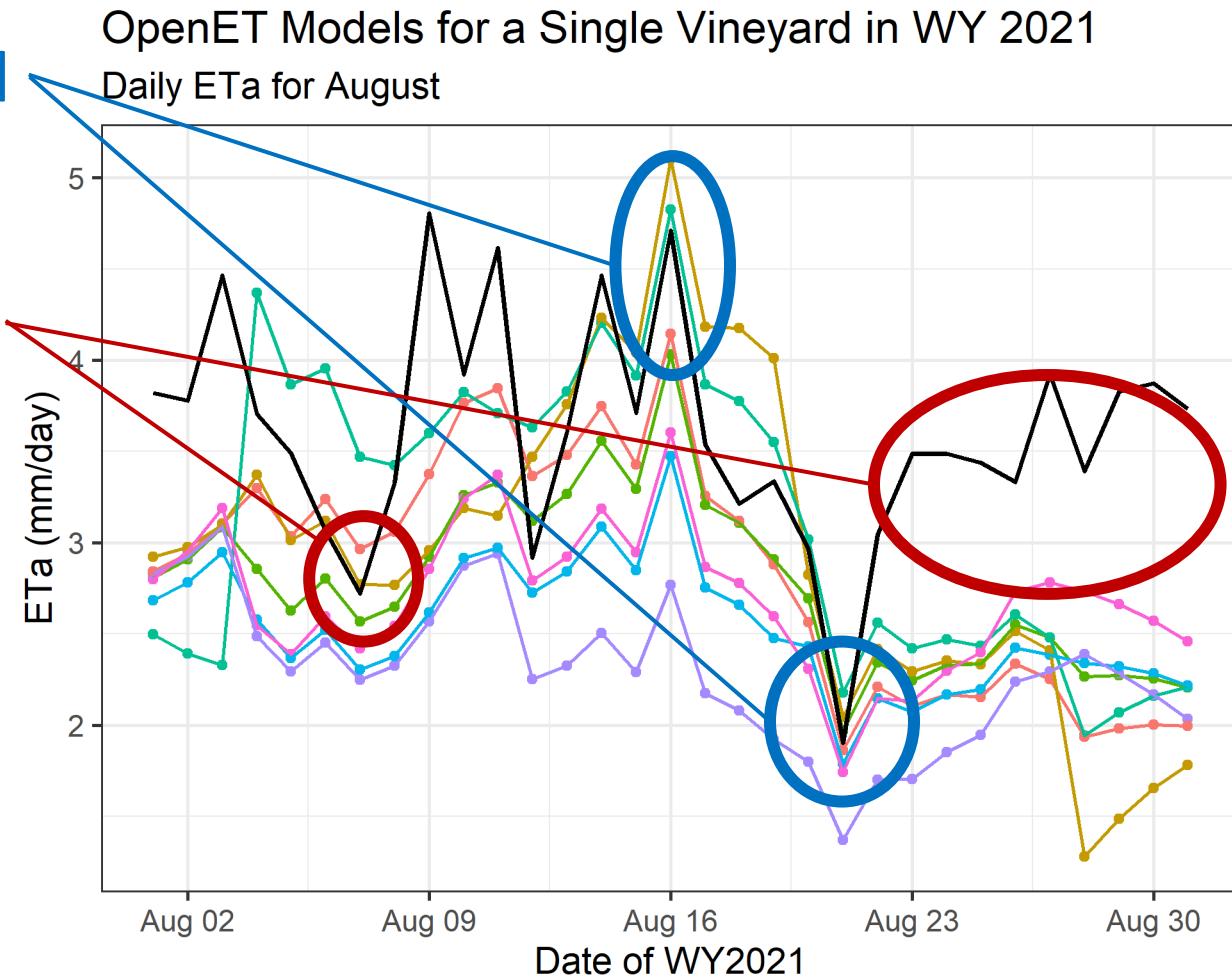


# OpenET and Measured Data – August 2021



Well Captured

Poorly Captured

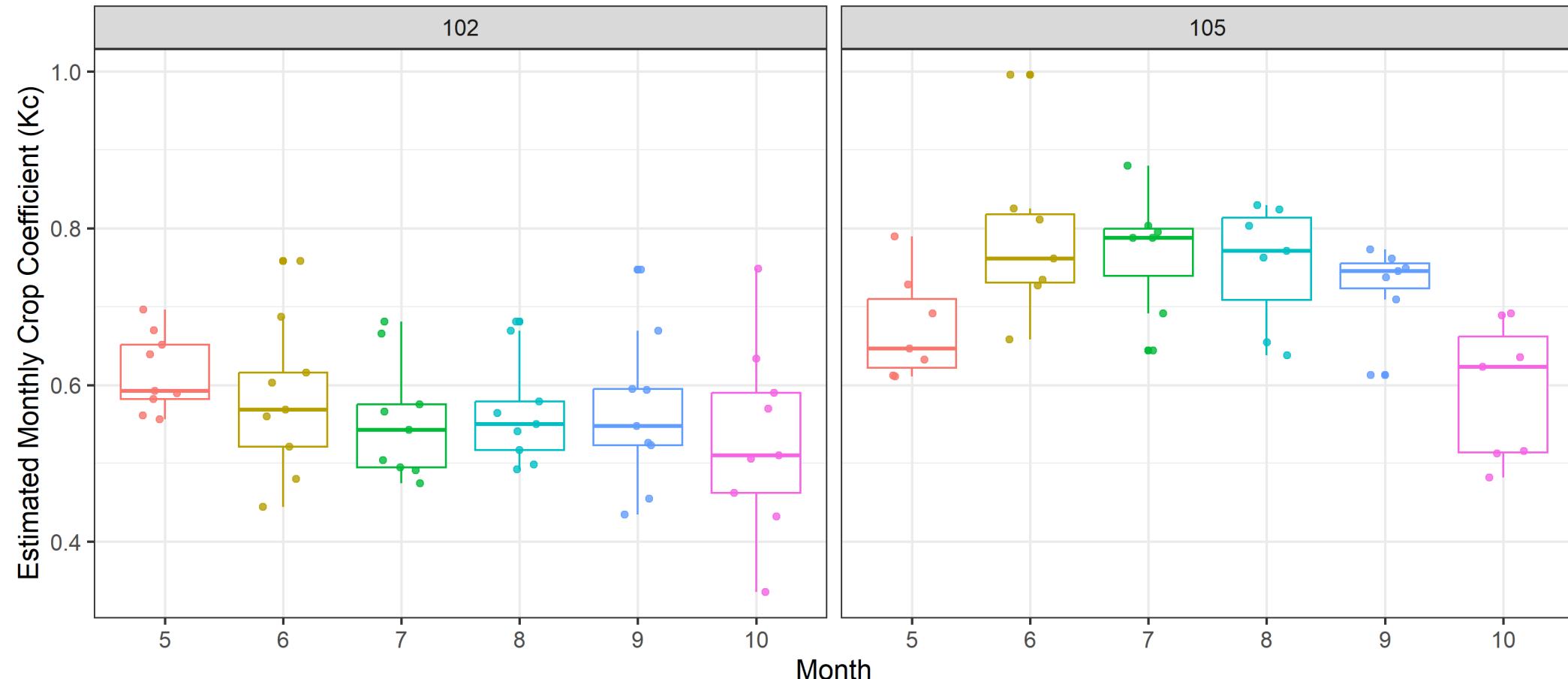


# Comparison of Locally Derived Kc Data



## Monthly Kc Variability of Two Vineyards in Napa Valley

May through October



# Range of Kc



## Questions to investigate:

- What factors influence changes in Kc from year-to-year?
  - Physical: Higher groundwater, climate not captured in the ETo
  - Cultural: Systems upgrade, multi-year cycle in soil amendments
- What factors, and to what extent do those factors, change Kc between fields?
  - Trellis class, irrigation type, planting density, rootstock, varietal, etc.

# Summary



- We have received measured ET data from 14 fields and begun preliminary data analysis.
- Identified potential bias introduced by CIMIS ETo calculations. We are working with DWR to understand and improve the network.
- Began quantifying the range of inter-field variability during a growing seasons.
- Began quantifying the range of intra-field variability over multiple growing seasons.
- Actively pursuing additional data and partners to better capture total consumptive use.



# Thank You

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