

Groundwater Demand Management: Quantifying crop consumptive use to support groundwater sustainability under SGMA

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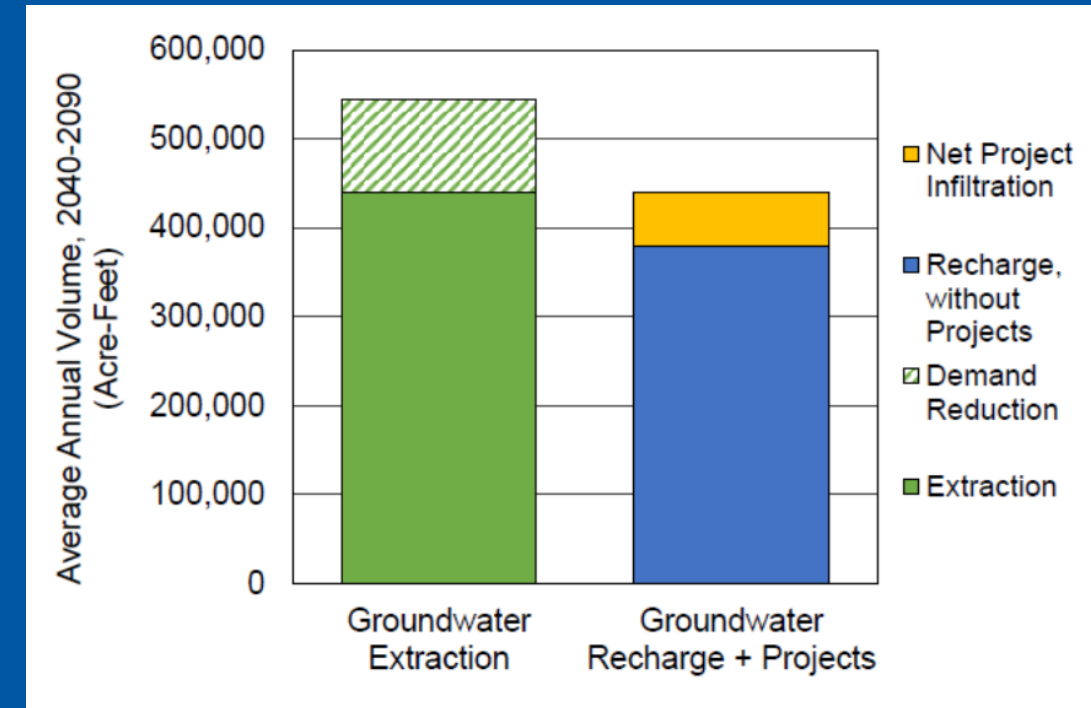
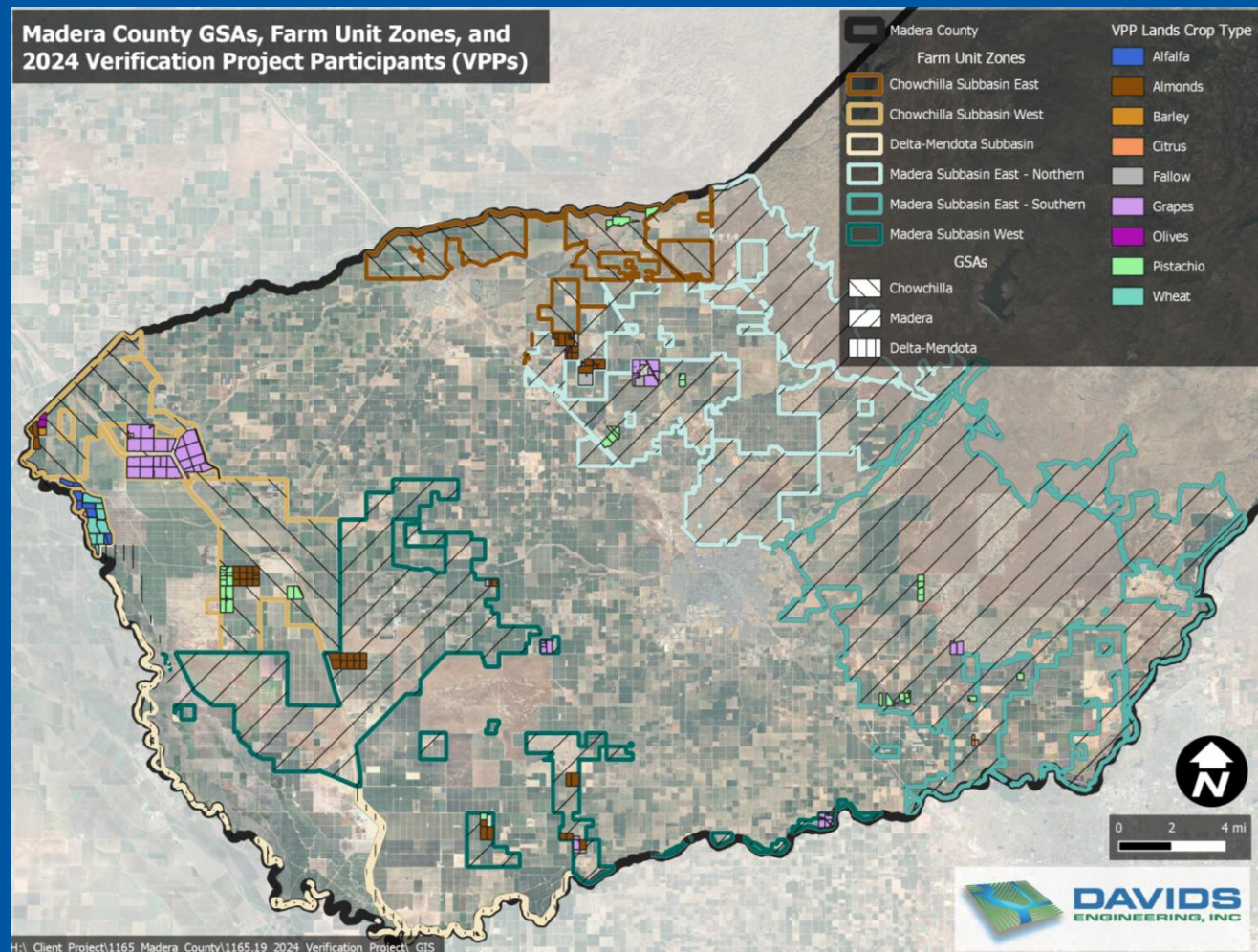
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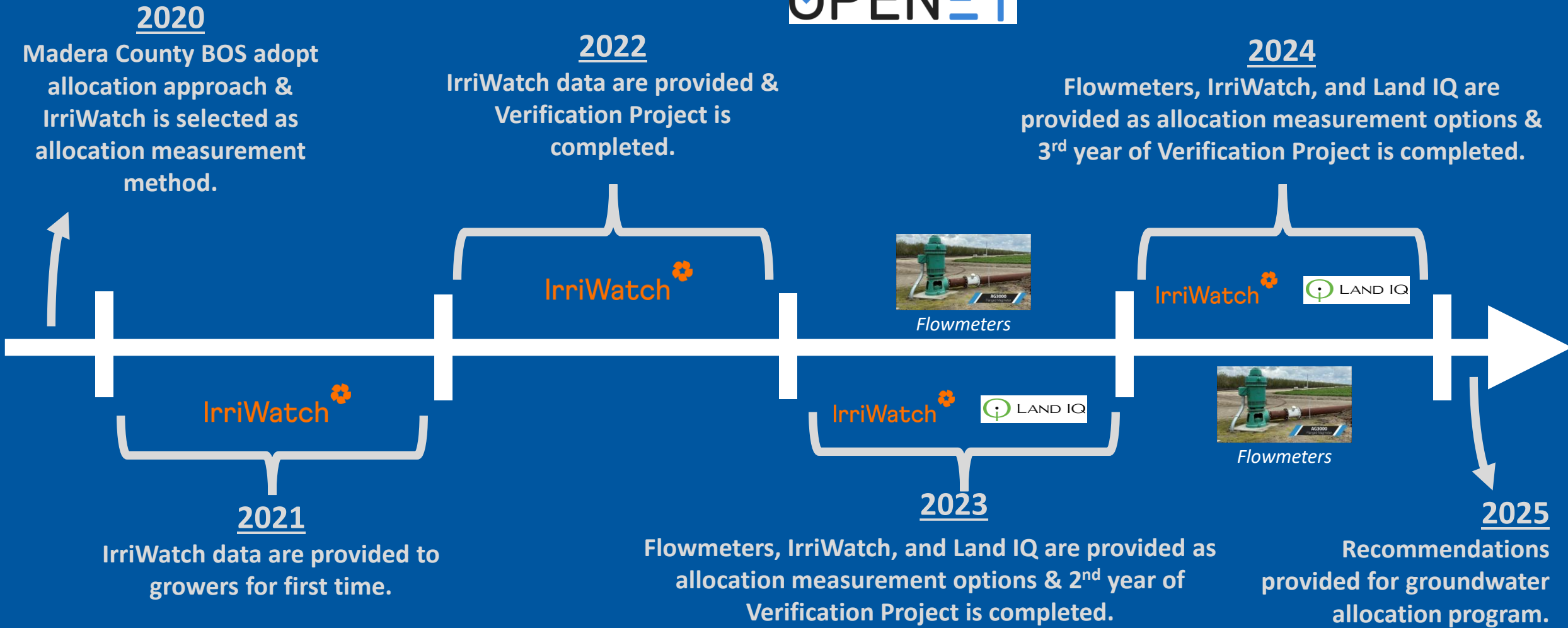
GDM plays a significant role in the Madera County GSAs groundwater sustainability plan



Madera Subbasin

Verification project years: 2022 to 2024

OPENET



Note: Although all references in this PowerPoint are to IrriWatch, in 2023, IrriWatch was purchased by Hydrosat.

Madera County's groundwater allocations are based on crop consumptive use (ETAW)

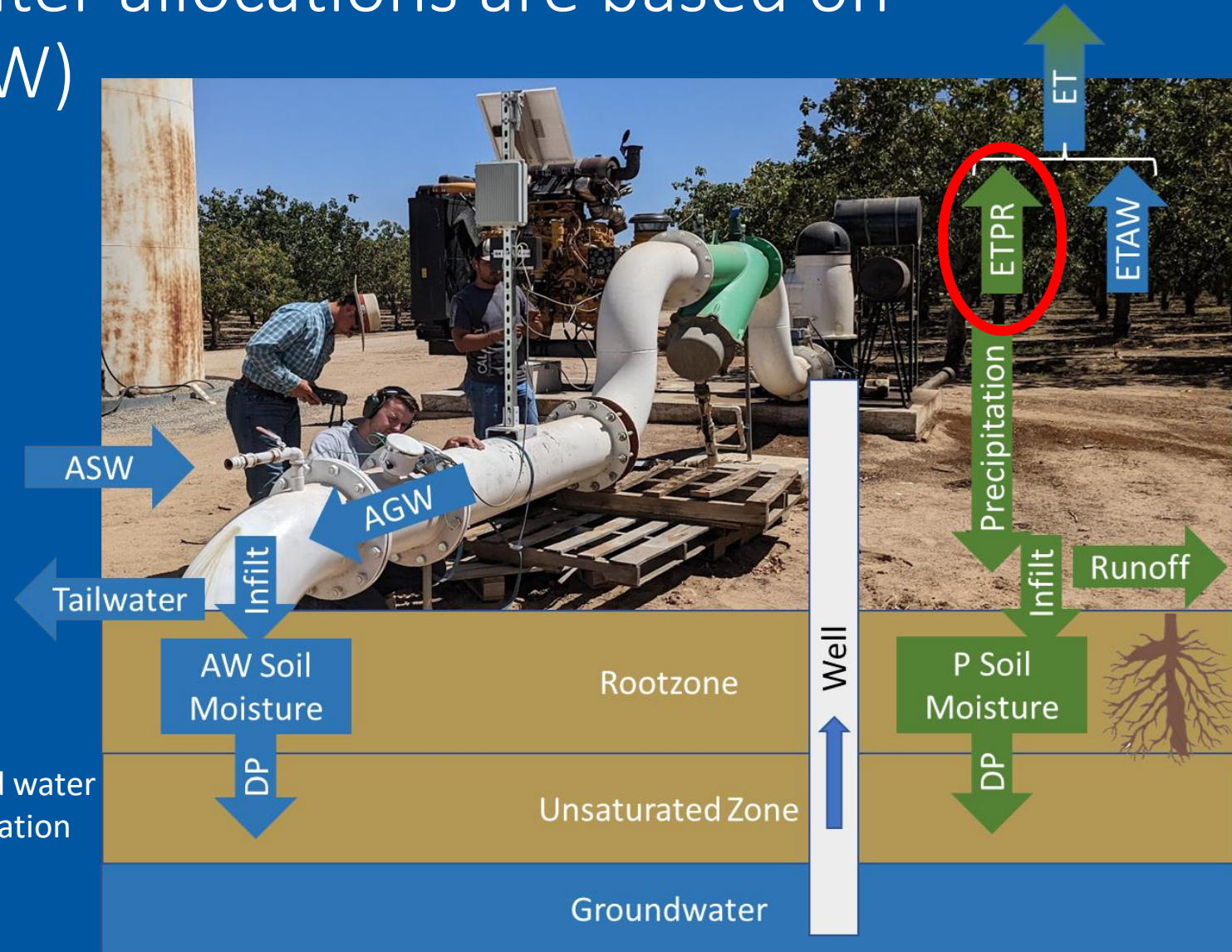
Flowmeters measure applied water

Remote sensing methods measure total evapotranspiration (ET)

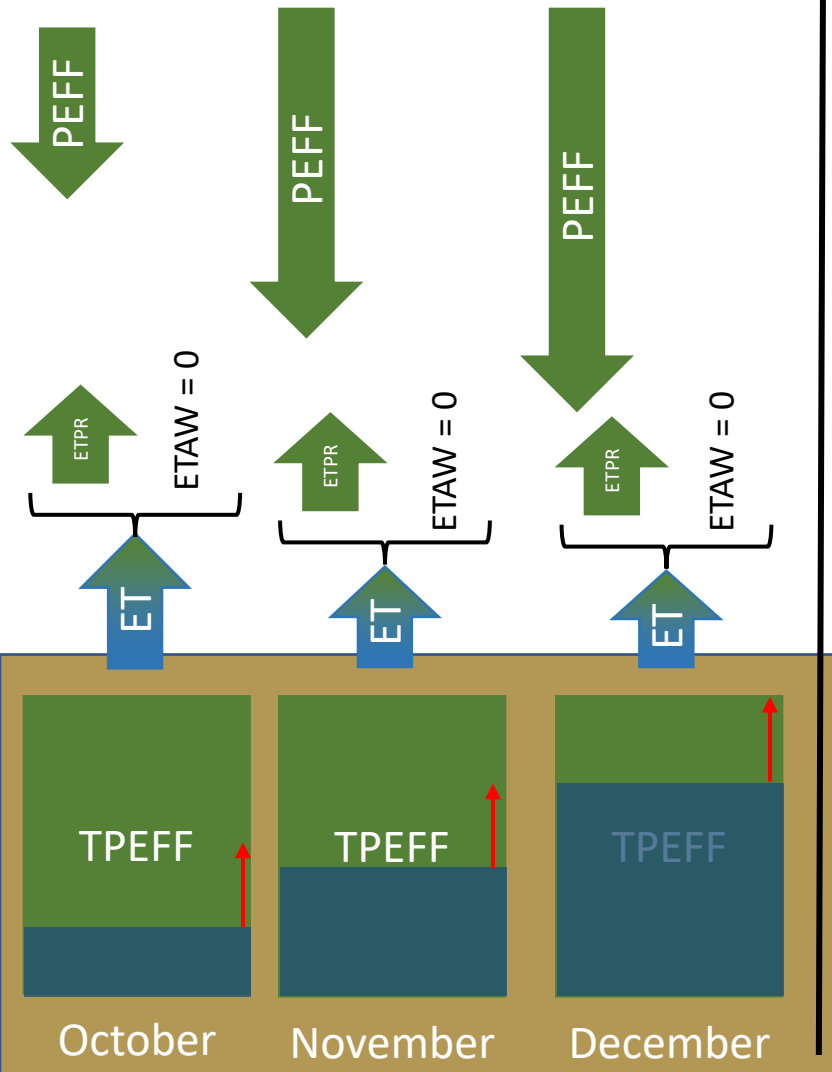
- $ETAW = ET - ETPR$

Consumptive Use Fraction (CUF) = $ETAW/AGW$

- CUF = Consumptive use fraction
- AGW = Applied groundwater
- ASW = Applied surface water
- P = Precipitation
- $ETAW$ = ET from applied water
- $ETPR$ = ET from precipitation
- Infiltration
- DP = Deep percolation

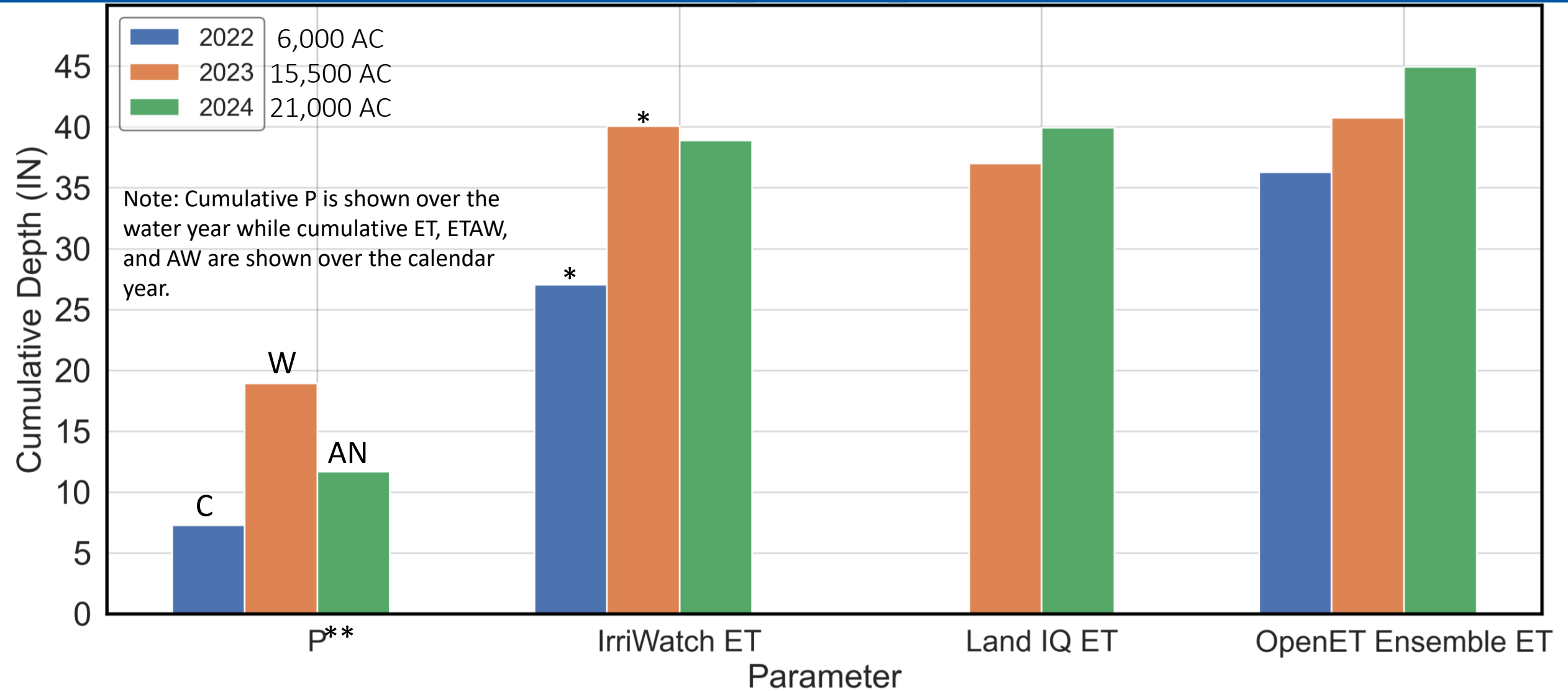


Oct – Dec 2022: Initialize soil moisture



PEFF = Effective
precipitation

TPEFF = Total
effective
precipitation

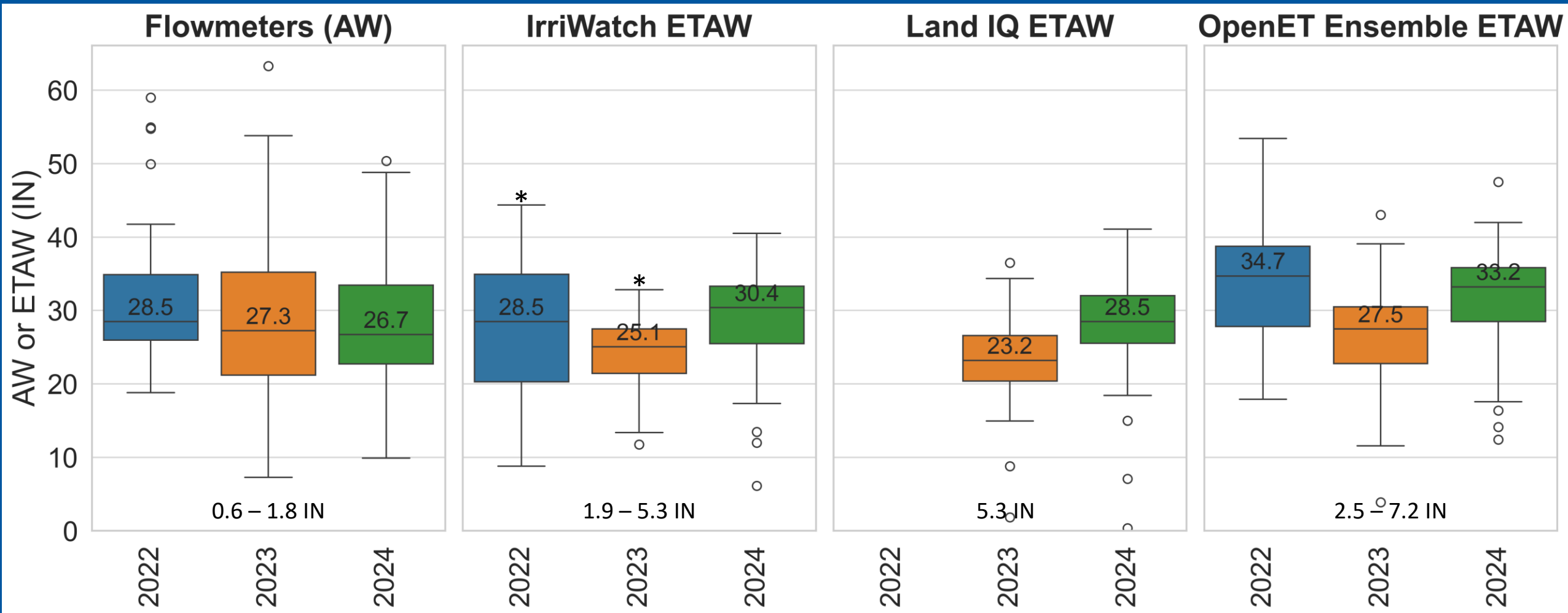


*IrriWatch ET/ETAW correction years: 2022 and 2023

**P = Based on water year (WY); data from PRISM for WY 2022, from PRISM (Oct-Feb 2022) and LandIQ (Mar-Sept 2023) for WY 2023, and from LandIQ for WY 2024

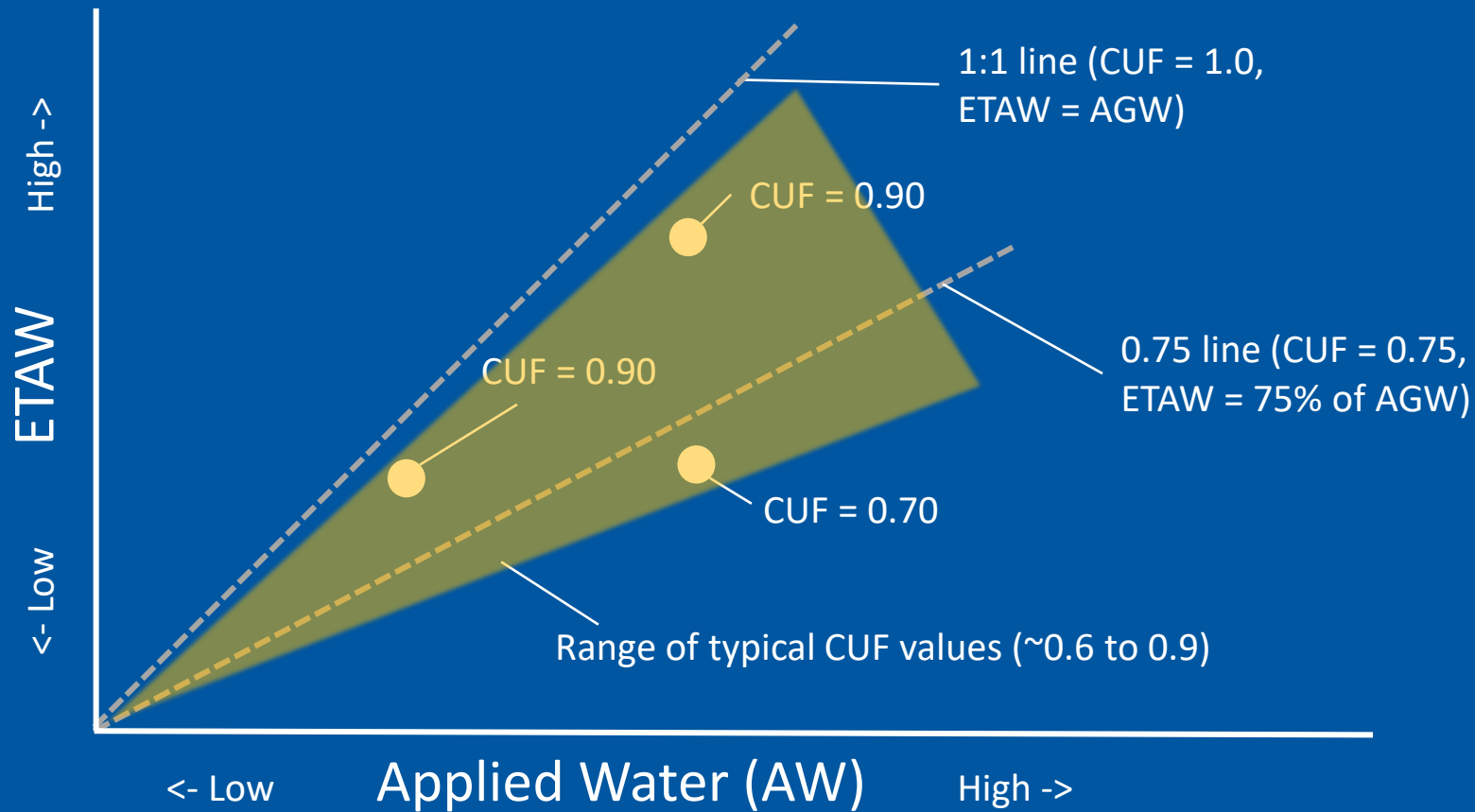
Comparisons Across Years

AW relatively consistent each year compared to ETAW



*IrriWatch ET/ETAW correction years: 2022 and 2023

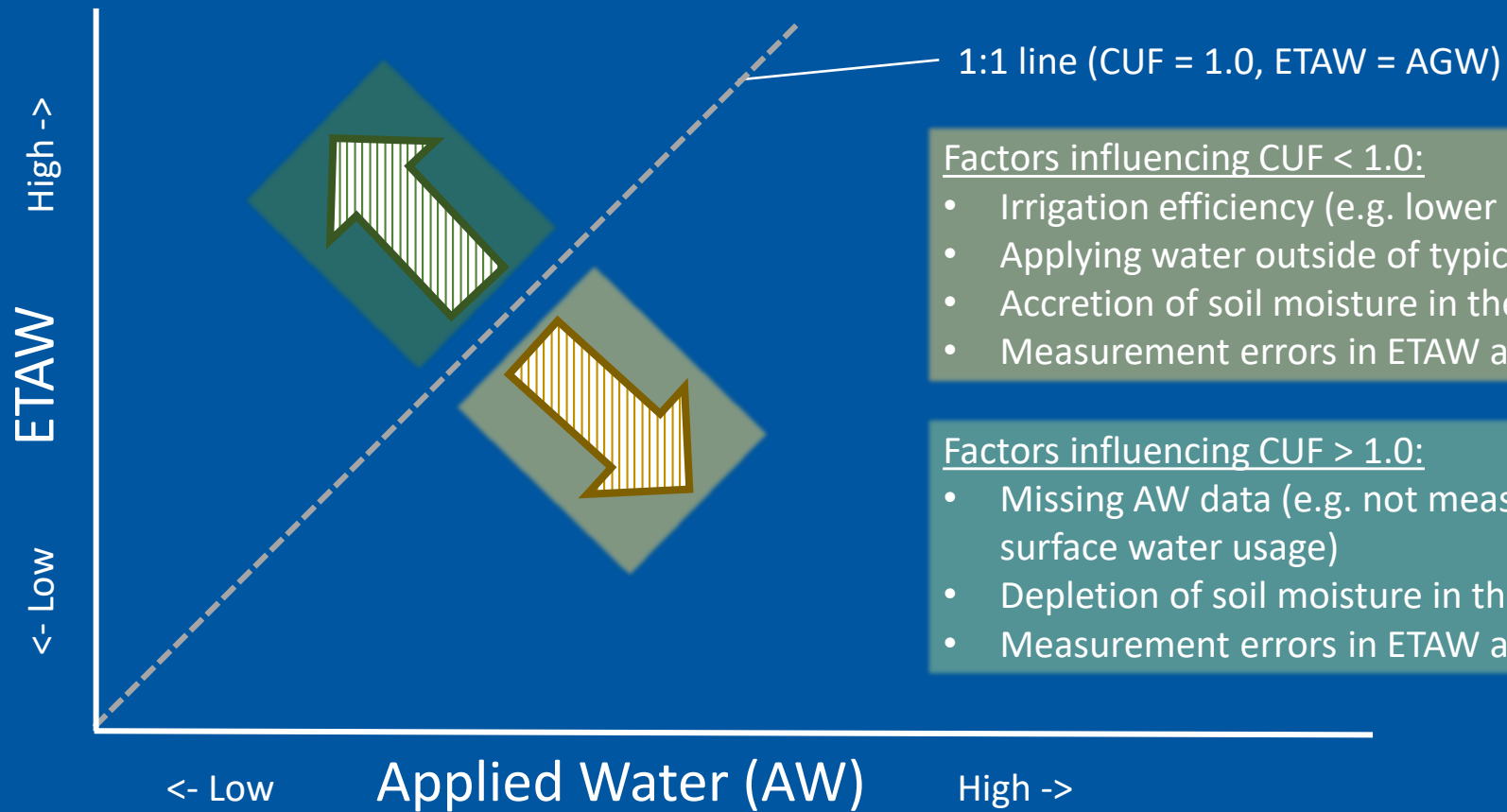
Let's take a closer look at the relationship between AW and ETAW across individual farms



Summary:

- Consumptive Use Fraction (CUF) equals ETAW divided by AW.
- CUF should be less than one (below the 1:1 line) since not all water applied will be consumed.
- The typical range of expected CUF values is from 0.6 to 0.9, dependent on a variety of factors.
- The following slide describes factors that may influence CUF values to be less than or greater than 1.0.

Several factors influence the variation in consumptive use fractions

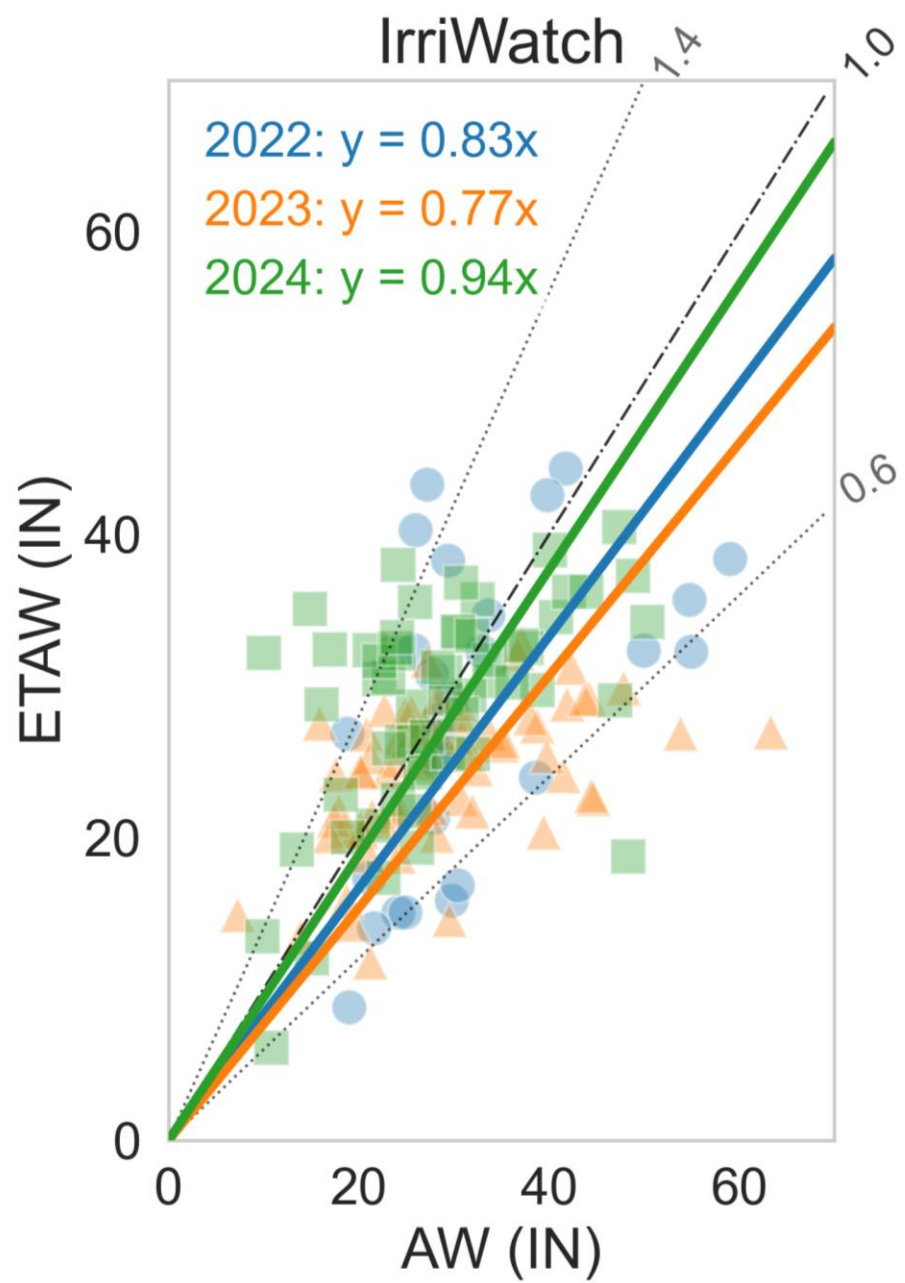


Factors influencing CUF < 1.0:

- Irrigation efficiency (e.g. lower efficiency -> lower CUF)
- Applying water outside of typical irrigation season (e.g. low ETAW)
- Accretion of soil moisture in the root zone
- Measurement errors in ETAW and AW / IU configuration errors

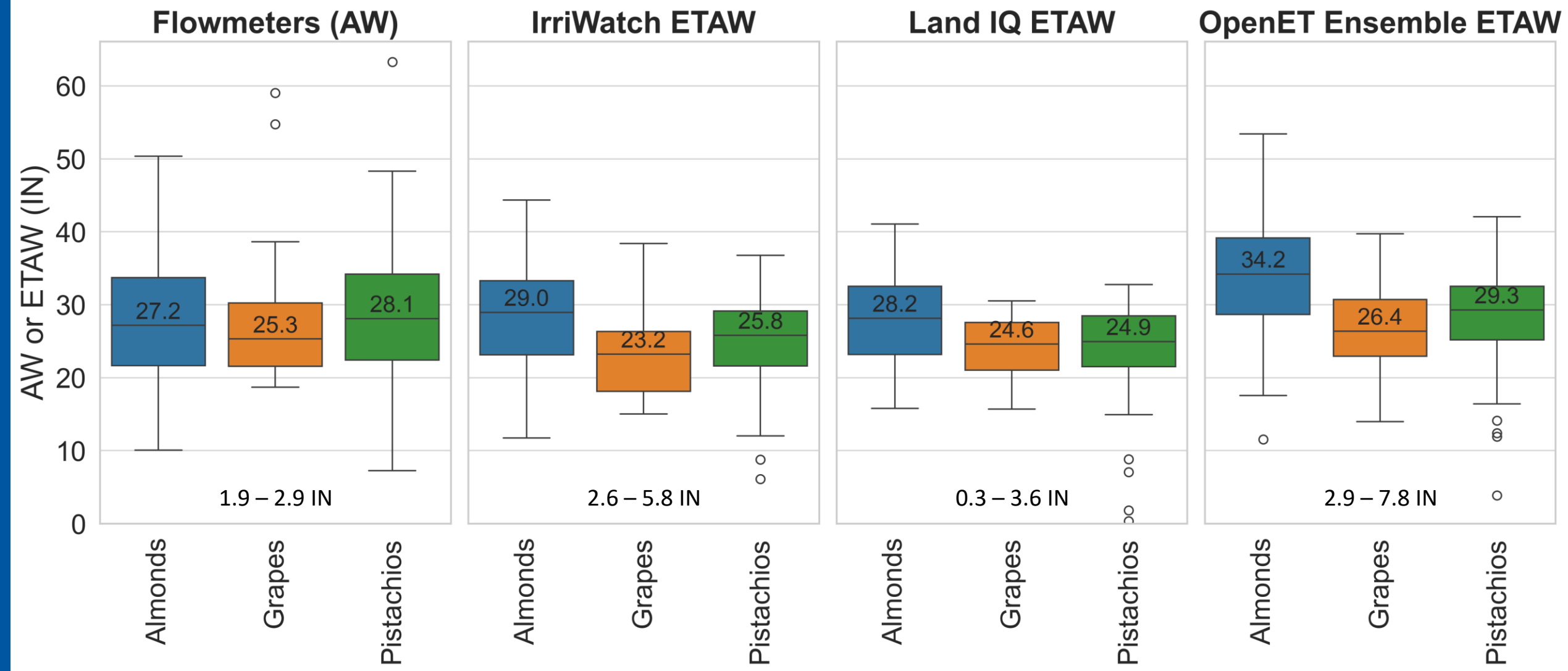
Factors influencing CUF > 1.0:

- Missing AW data (e.g. not measuring all irrigation wells, unaccounted for surface water usage)
- Depletion of soil moisture in the root zone
- Measurement errors in ETAW and AW / IU configuration errors



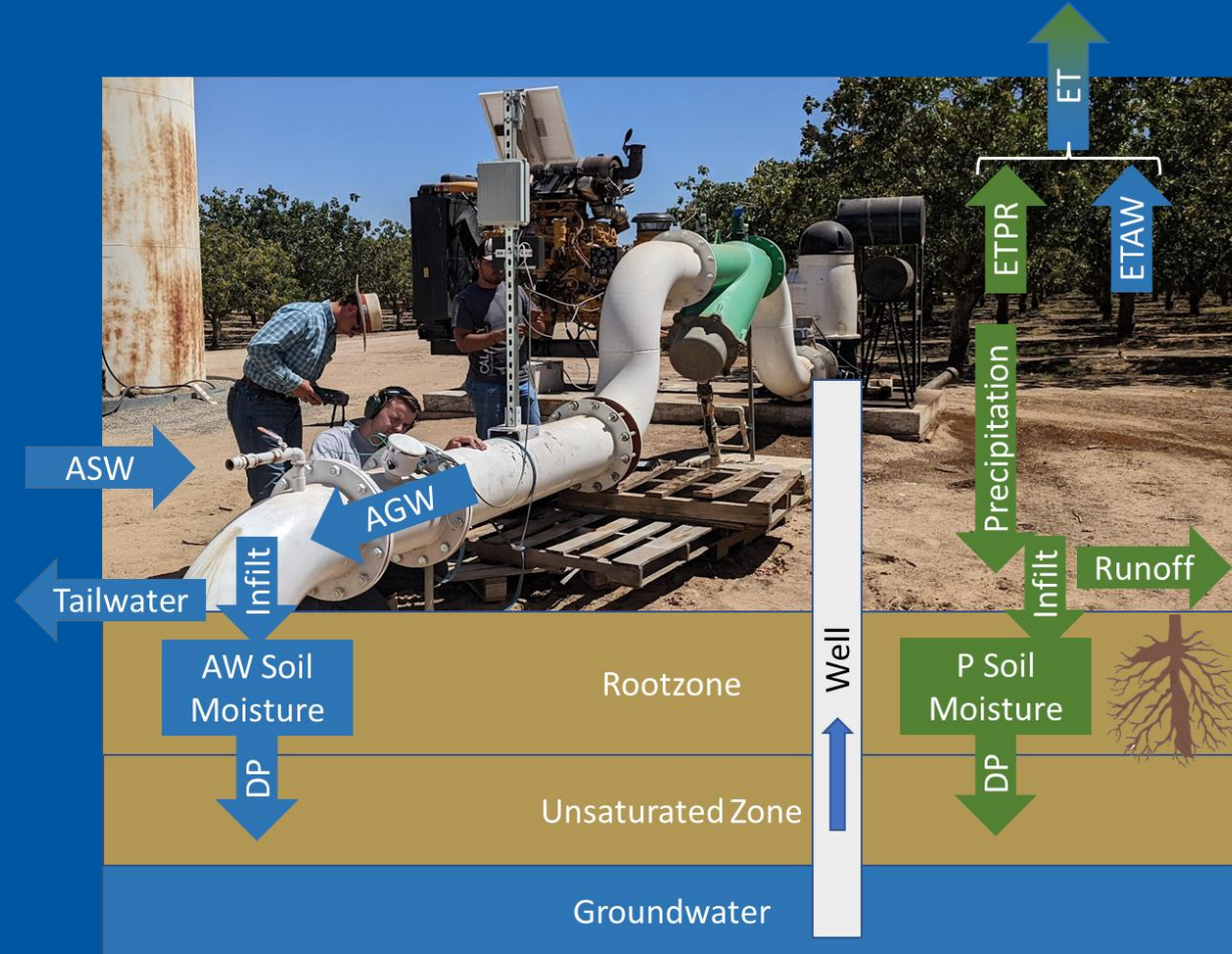
Comparisons Across Crops

ETAW generally higher over almonds



In summary...

1. Comparison across project years (water year types included: Critical, Wet, Above Normal) and crop types (primary crops: Almonds, Grapes, Pistachios)
2. Year comparisons
 - a. Larger difference in ETAW compared to AW across project years – responding to changes in total ET and effective precipitation
 - b. Representative CUFs changed each year
3. Crop comparisons
 - a. ETAW generally higher over almond farms



Questions?



EXTRAS

Effective Precipitation (PEFF)

- Effective precipitation method originally proposed by the United States Bureau of Reclamation (USBR) in 1967 (USBR method)
- Initially refined/localized to match modeling results from GSP preparation
- Further refined/localized based on actual observations of ET from fallowed fields (*i.e.*, fields with no applied water)

Monthly Precipitation Increment (in)	Effective Precipitation (%)
0.0 - 0.5	95
0.5 - 1.0	85
1.0 - 1.5	75
1.5 - 2.0	70
2.0 - 2.5	65
2.5 - 3.0	60
> 3.0	50

USBR PEFF Example

- Example: Calculate effective precipitation (PEFF), for May with 2.3 IN of precipitation.
- Result: For May, effective precipitation (PEFF) was 1.8 IN or 78% of precipitation (2.3 IN)

(1) Precipitation Increment (IN)	(2) Standard Average Effectiveness (%)	(3) Precipitation (P) within Increment (IN)	(4) Effective Precipitation (PEFF) within Increment (IN)
0.0 - 0.5	95	0.5	$0.5 * 0.95 = 0.48$
0.5 - 1.0	85	0.5	$0.5 * 0.85 = 0.43$
1.0 - 1.5	75	0.5	$0.5 * 0.75 = 0.38$
1.5 - 2.0	70	0.5	$0.5 * 0.70 = 0.35$
2.0 - 2.5	65	0.3	$0.3 * 0.65 = 0.20$
2.5 - 3.0	60	0.0	$0.0 * 0.60 = 0$
Greater than 3.0	50	0.0	$0.0 * 0.50 = 0$
Totals ->		$0.5 + 0.5 + 0.5$ $+ 0.5 + 0.3 =$ <u>2.3</u>	$0.48 + 0.43 + 0.38 + 0.35 +$ $0.20 =$ <u>1.8</u>

