2023

THE ALMOND CONFERENCE

Connecting the Dots

GROWERS // HANDLERS // CUSTOMERS // CONSUMERS

Automation— A Key to Precision Irrigation Management

Moderators: Tom Devol (ABC), Sebastian Saa (ABC)

Speakers: Andrew McElrone (USDA ARS), James Nichols (HotSpot Ag), Jacob Christfort (Ranch Systems), Andres Olivos (OLIVOS Irrigation), Guillermo Valenzuela (Wiseconn)

2023

THE ALMOND CONFERENCE

Connecting the Dots

GROWERS // HANDLERS // CUSTOMERS // CONSUMERS

Sebastian Saa

Associate Director Ag. Research, ABC

ABC Irrigation Research Portfolio

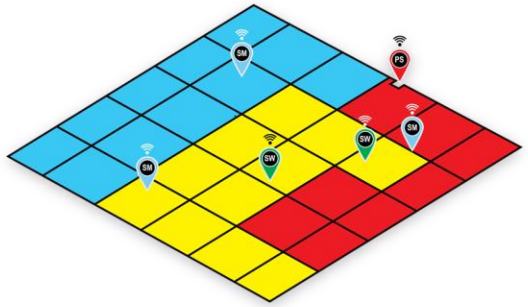
Designed for Flexibility

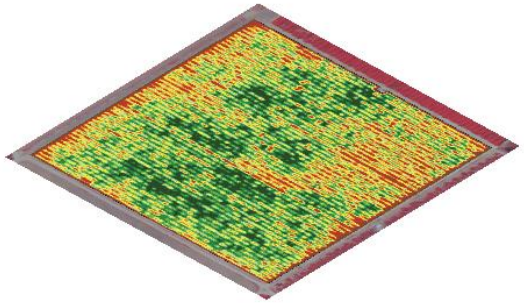
Tree sensors

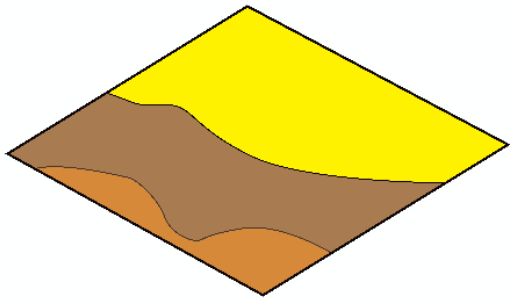
Actual and spatial tree evap. (ETa)

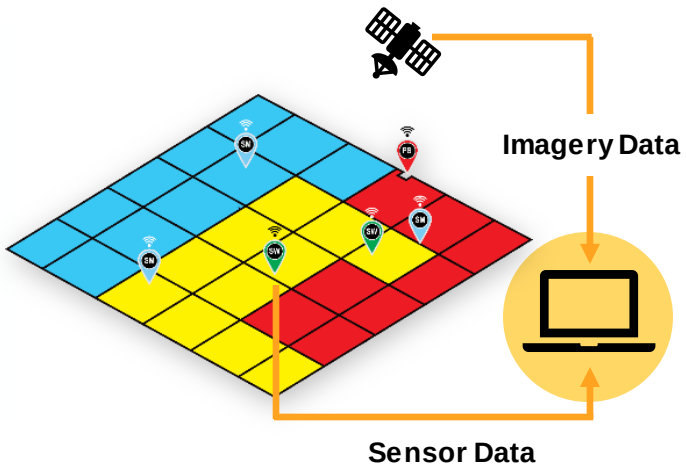
Yield spatial variability

Smart controllers







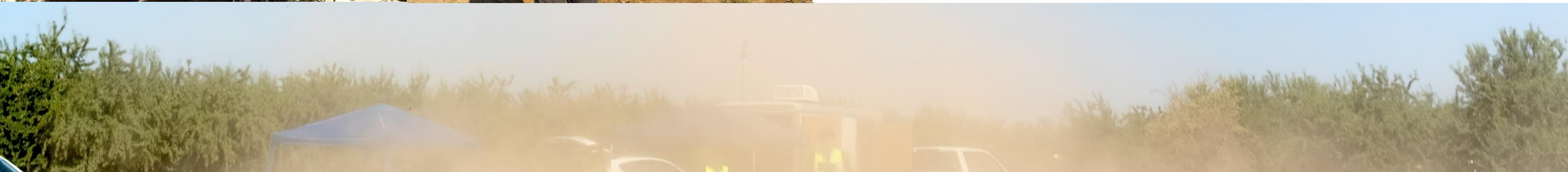


california almonds
Almond Board of California

Helping Growers Irrigate the Right Amount

T-REX

Tree crop Remote sensing of Evapotranspiration eXperiment



Evapotranspiration of the Cultivar ETc

Scheduling Based on ETc Data

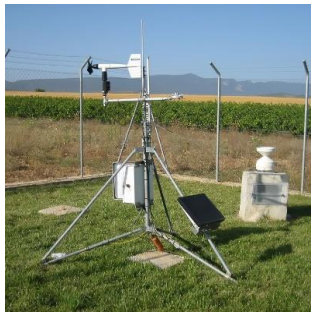
69%	75%
2016	2021

$$ETc = ETo \times Kc$$

ETc (almonds) = Total evapotranspiration adjusted for crop.(the amount of water use by a crop)

ETo = Measured evapotranspiration of a well mowed grass.
~ 0.28 inches per day in July.

Kc = Crop coefficient (the correction factor to translate ETo to a certain crop)



ETo data from Weather Station

×

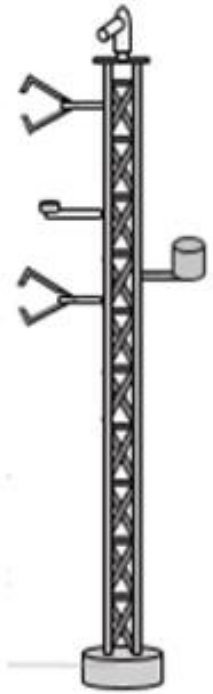
Almond Crop Co-Efficients by Month											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.4	0.41	0.62	0.80	0.94	1.05	1.11	1.11	1.06	0.92	0.69	0.43

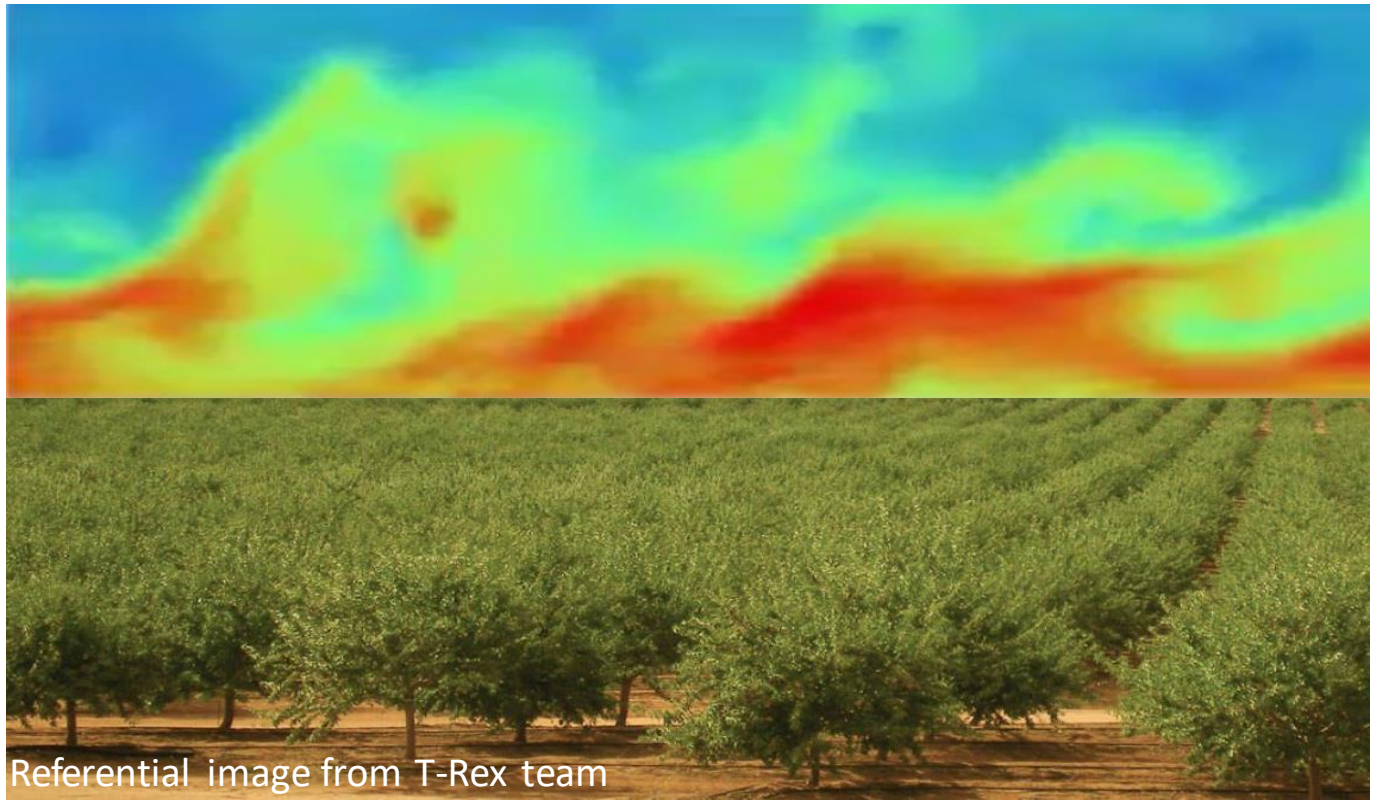
Kc data from co-efficient table for crop

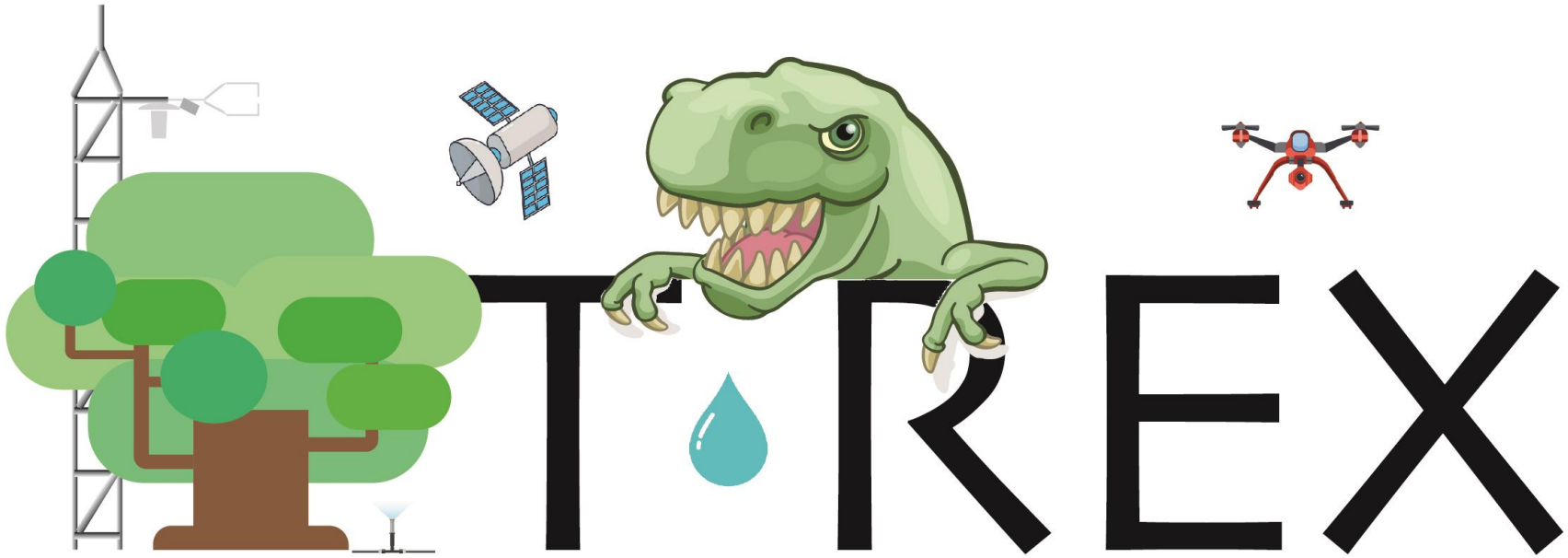
= **How Much to Irrigate**

Actual ET visualized by the Flux Towers

- Foundational work



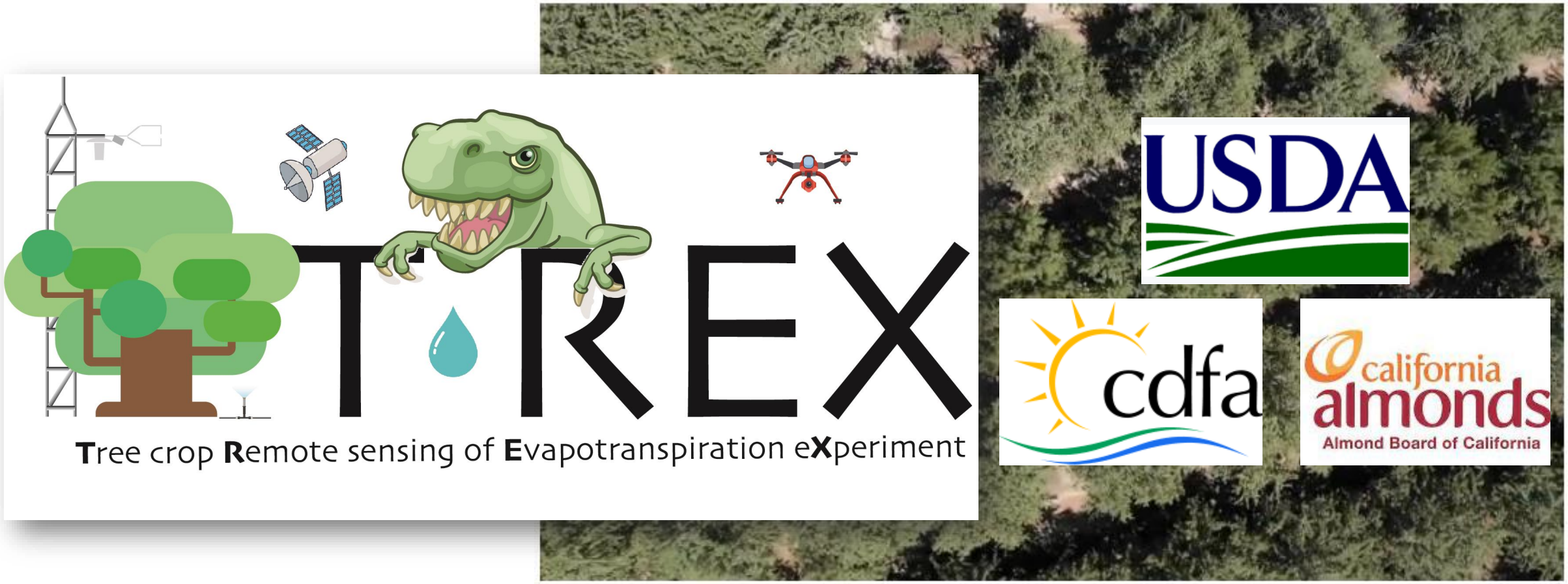




Tree crop **R**emote sensing of **E**vapotranspiration e**X**periment

T-REX Project Research Update

ABC Annual Conference
December 2023
Andrew McElrone



USDA Agricultural Research Service | UC DAVIS UNIVERSITY OF CALIFORNIA | UC ANR | UtahState University | California State University MONTEREY BAY | NASA EARTH SCIENCE APPLIED SCIENCES | COMPLUTIG EMPRESA DE BASE TECNOLÓGICA DE LA UNIVERSIDAD DE ALCALÁ

Nicolas Bambach, Kyle Knipper, Andrew McElrone, William Kustas, Mallika Nocco, Alfonso Torres-Rua, Seba Castro-Bustamante, Ethan Frehner, Andy Gal, Apoorva Jha, Ian Wright, Erica Edwards, Martha Anderson, Brian Bailey, Tom Buckley, Lawrence Hipps, Isaya Kisekka, Forrest Melton, Hector Nieto, John Prueger, Joe Alfieri….

How much, when, where to irrigate?

tree water use

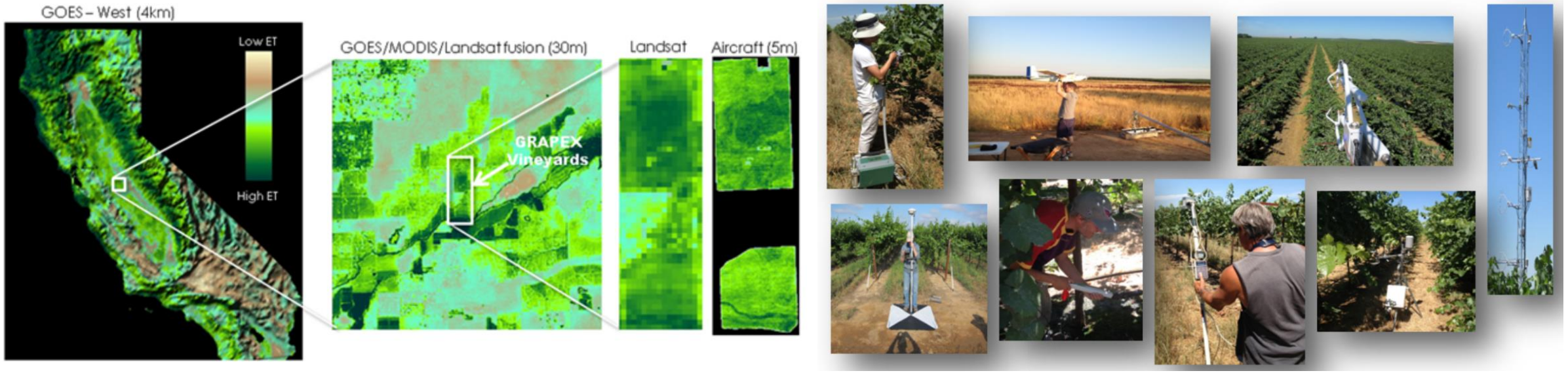
tree water stress

spatial variability

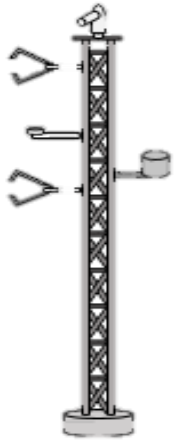
Tools needed to quantify water use over large acreage, approach stress thresholds, and achieve production goals

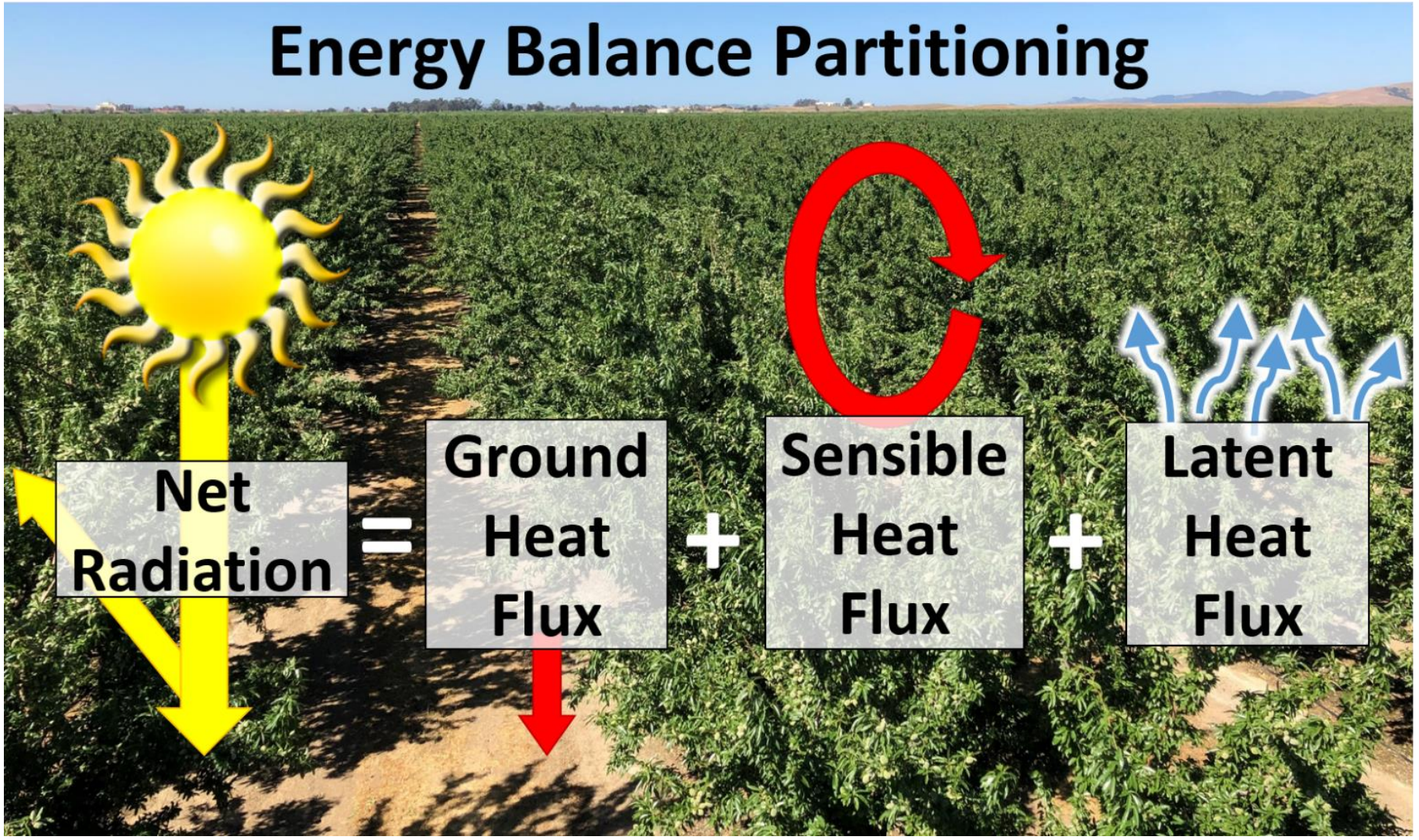
Grape Remote sensing Atmospheric Profile & Evapotranspiration eXperiment

Refine and apply a multi-scale remote sensing ET toolkit for mapping crop water use and stress for improved irrigation management in California



Energy Balance Approaches to Quantify ET



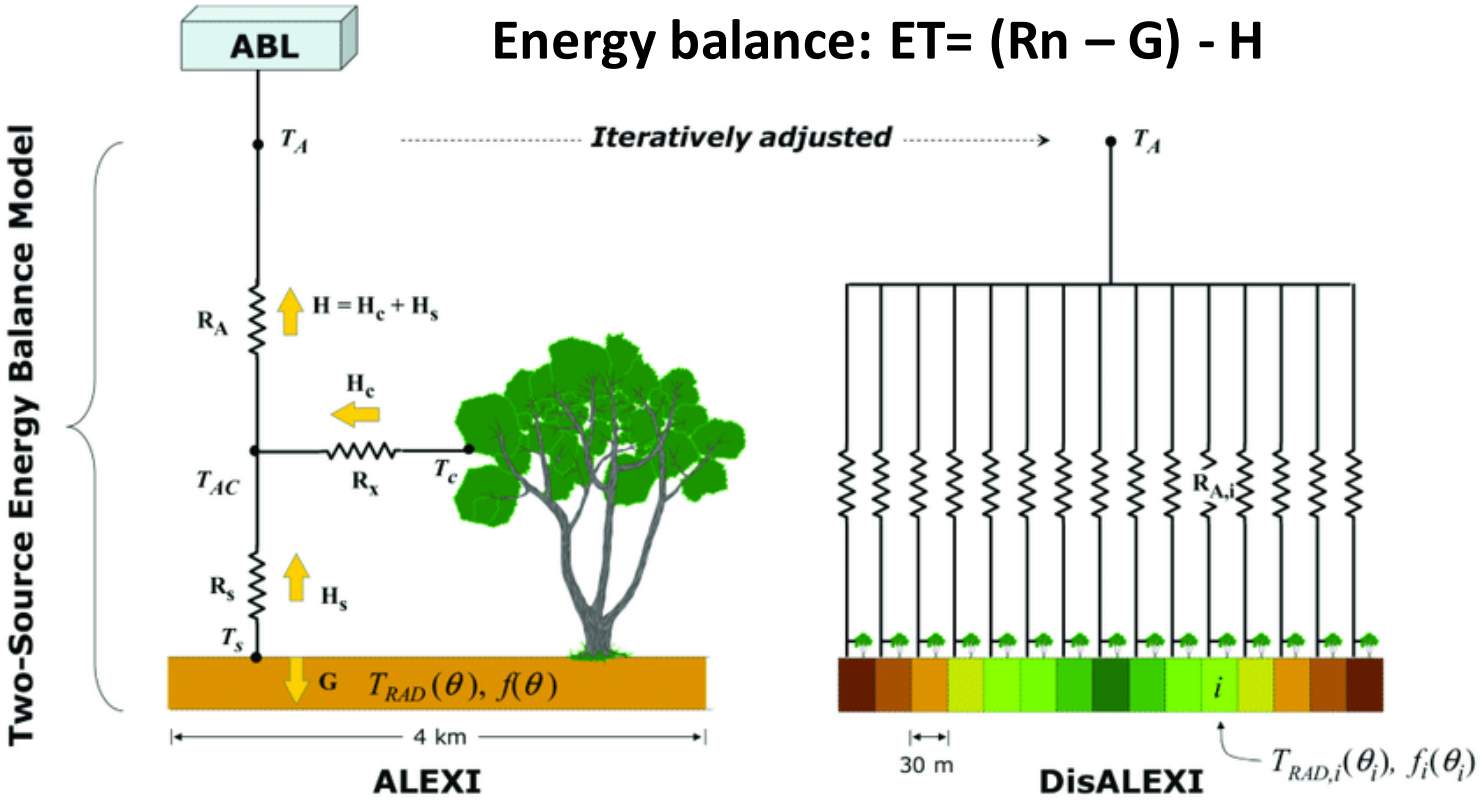


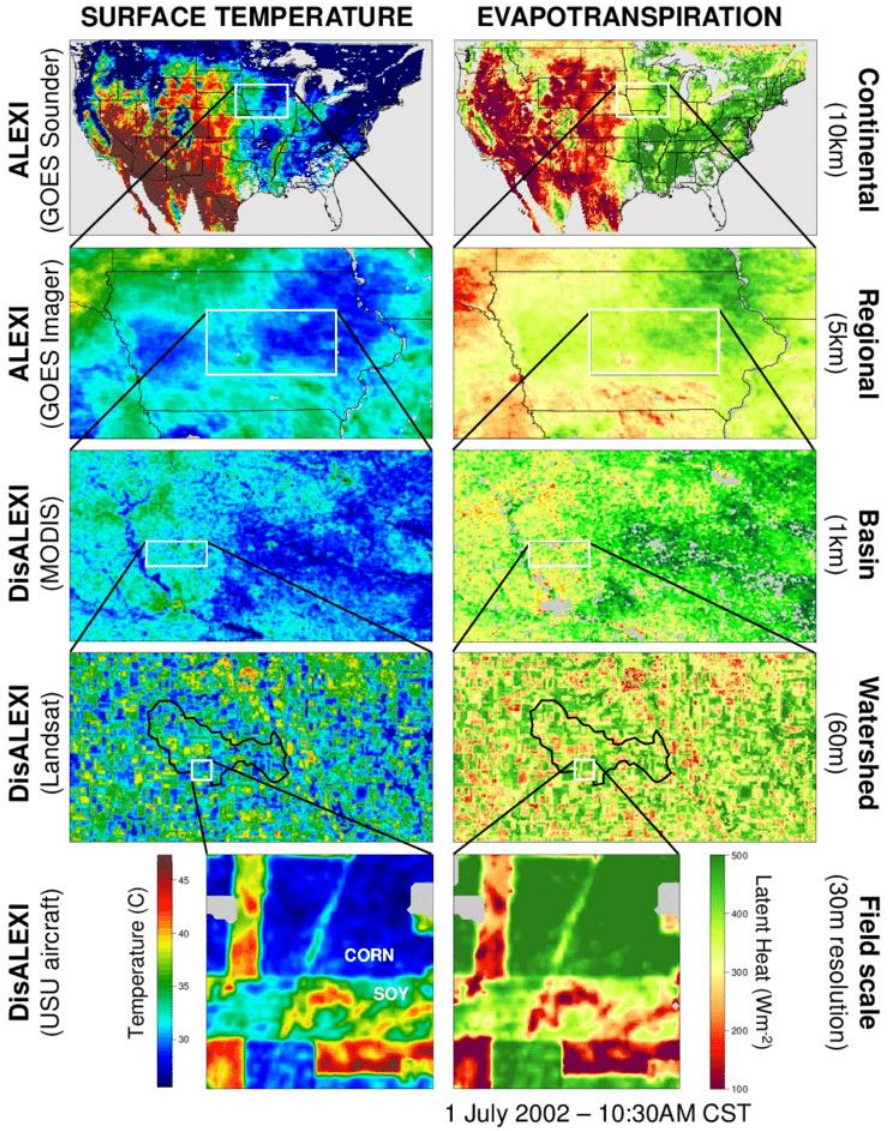
Satellite Remote Sensing

ALEXI + DisALEXI Evapotranspiration (ET) Modeling Suite

Spatially resolved water use to promote uniform production via precision irrigation in almond orchards

Energy balance: ET= (Rn – G) - H

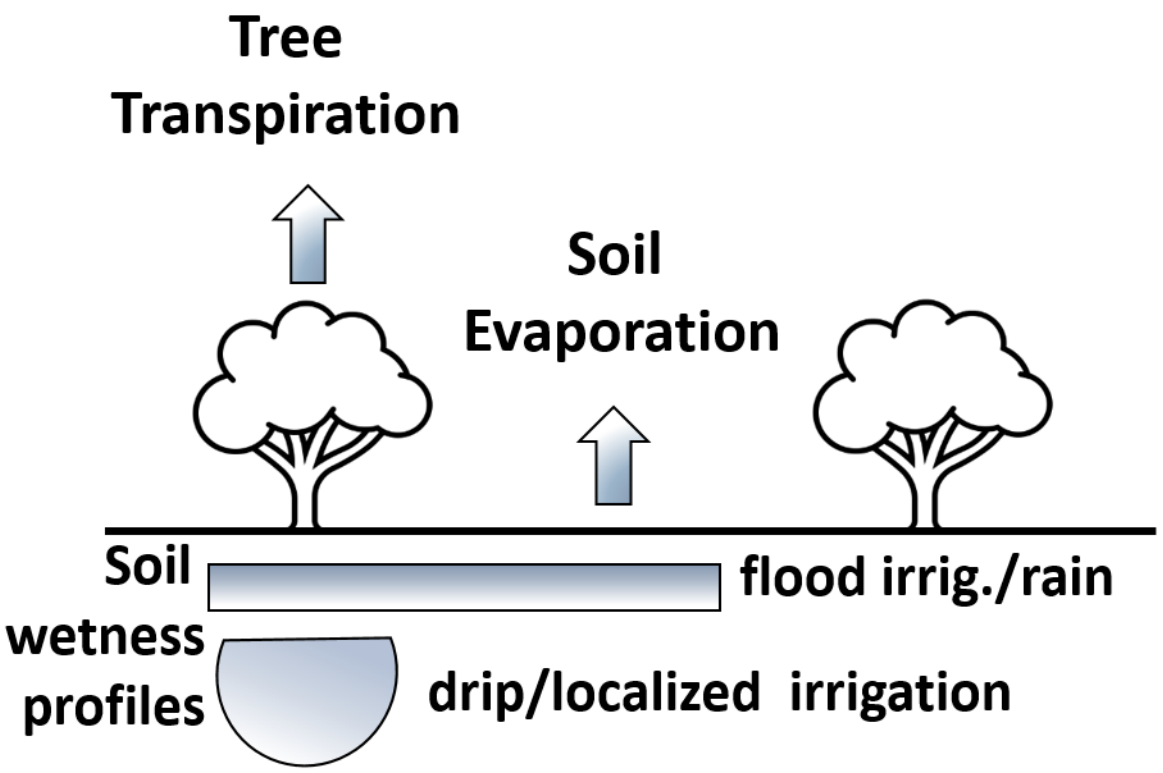


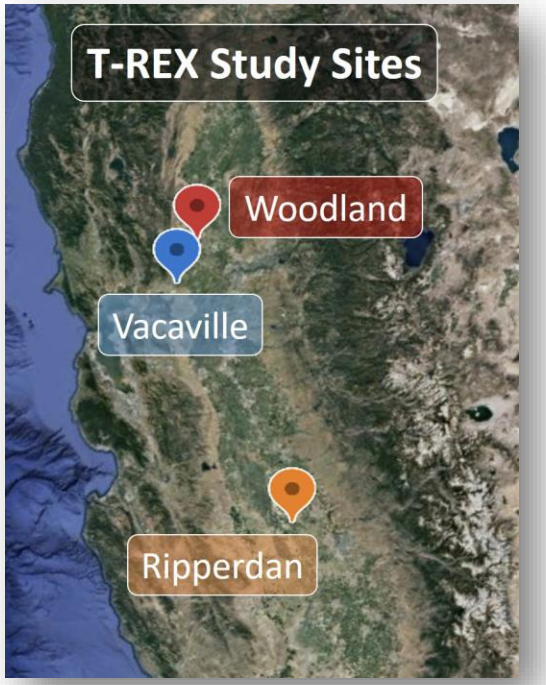


Satellite Remote Sensing

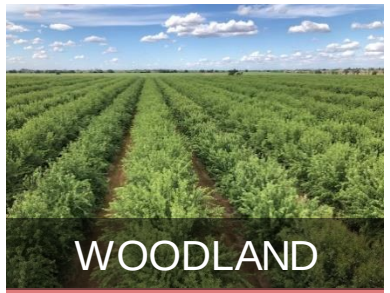
ALEXI + DisALEXI Evapotranspiration (ET) Modeling Suite

Spatially resolved water use to promote uniform production via precision irrigation in almond orchards





Coordinated efforts with Single Tree Harvesting Project (Brown et al.)



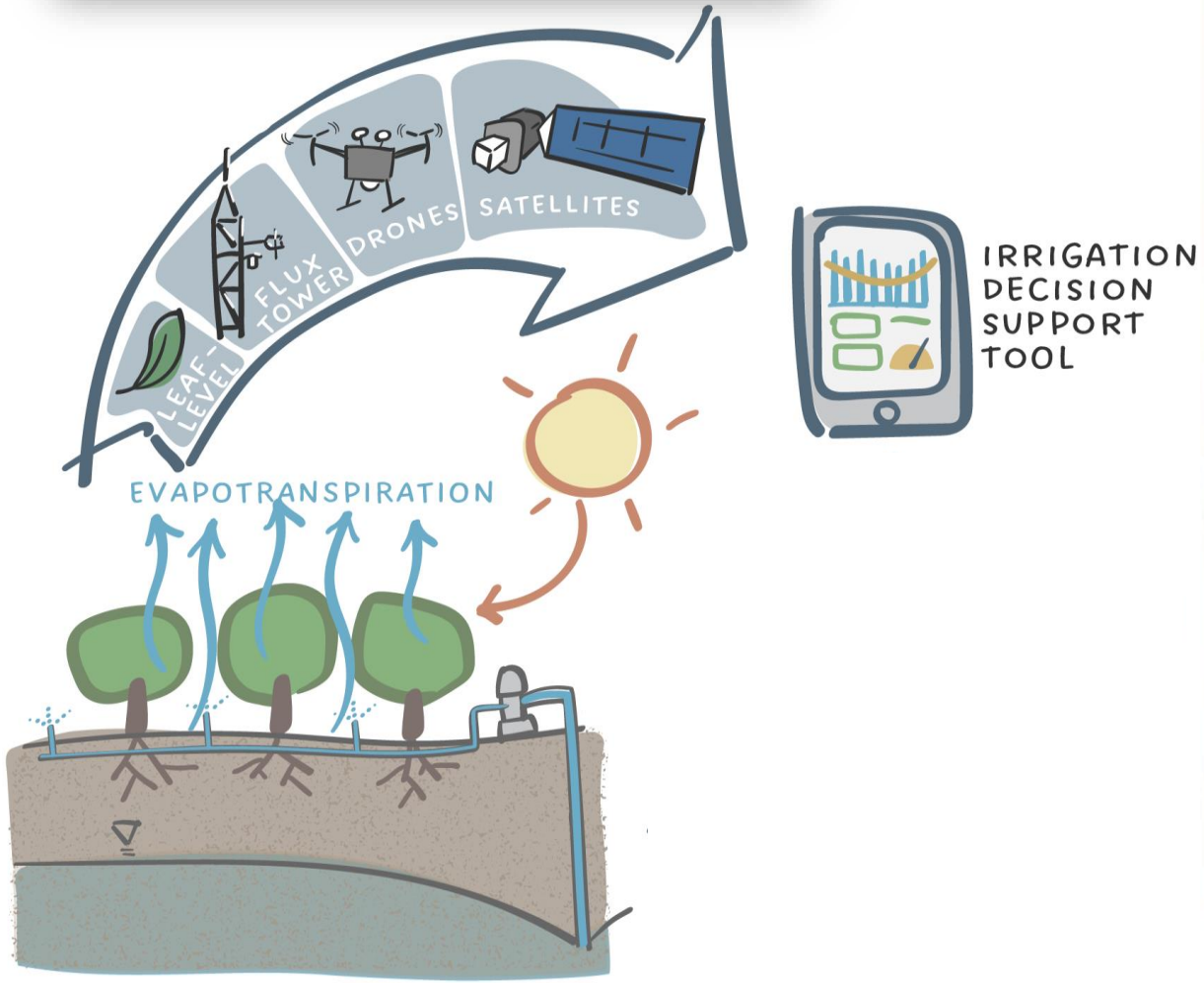
9th leaf
Non-pareil-50% | Monterey, Butte & Carmel-17%

7th leaf
Independence -100%
Silty clay loam soil

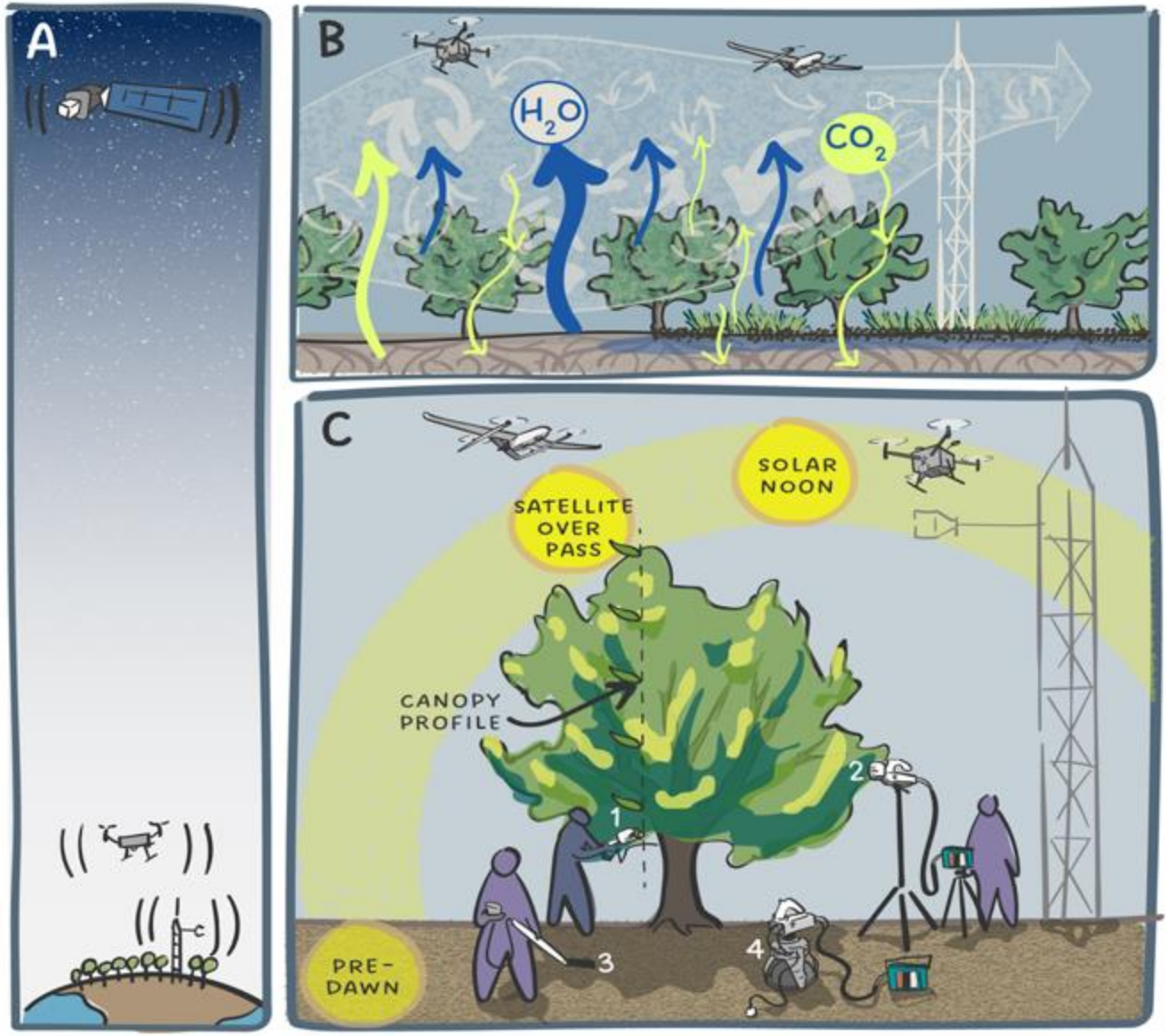
8th leaf
Non-pareil-50%,Wood Colony-37%, Supareil-13%

T·REX

Tree crop **R**emote sensing of **E**vapotranspiration e**X**periment



IRRIGATION DECISION SUPPORT TOOL

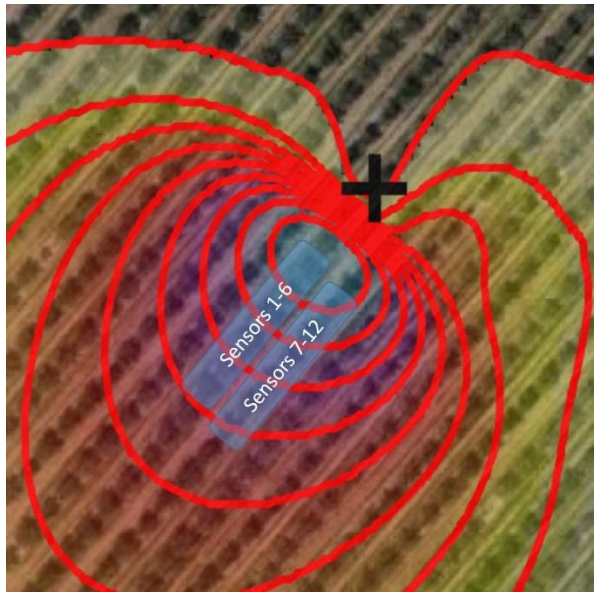


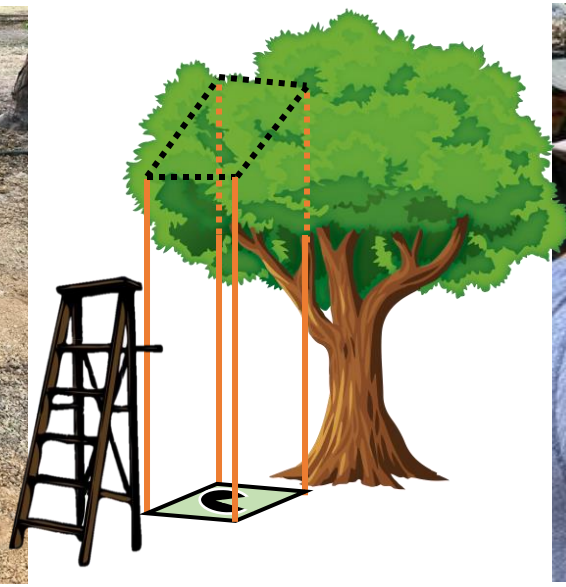
Original Artwork by Dr. Bonnie McGill

Ground Truthing Efforts from 2021-2023

Site selection, tower installation, maintenance

Soil and tree sensors, regular physiological measurement campaigns





Ground Truthing Efforts – 2022 Schedule

February 2022–January 2023 (United States)

timeanddate

February 2022

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28					

March 2022

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

April 2022

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

May 2022

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

June 2022

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

July 2022

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

August 2022

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

September 2022

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

WOODLAND

9th leaf
Non-pareil-50% | Monterey, Butte & Carmel-17%

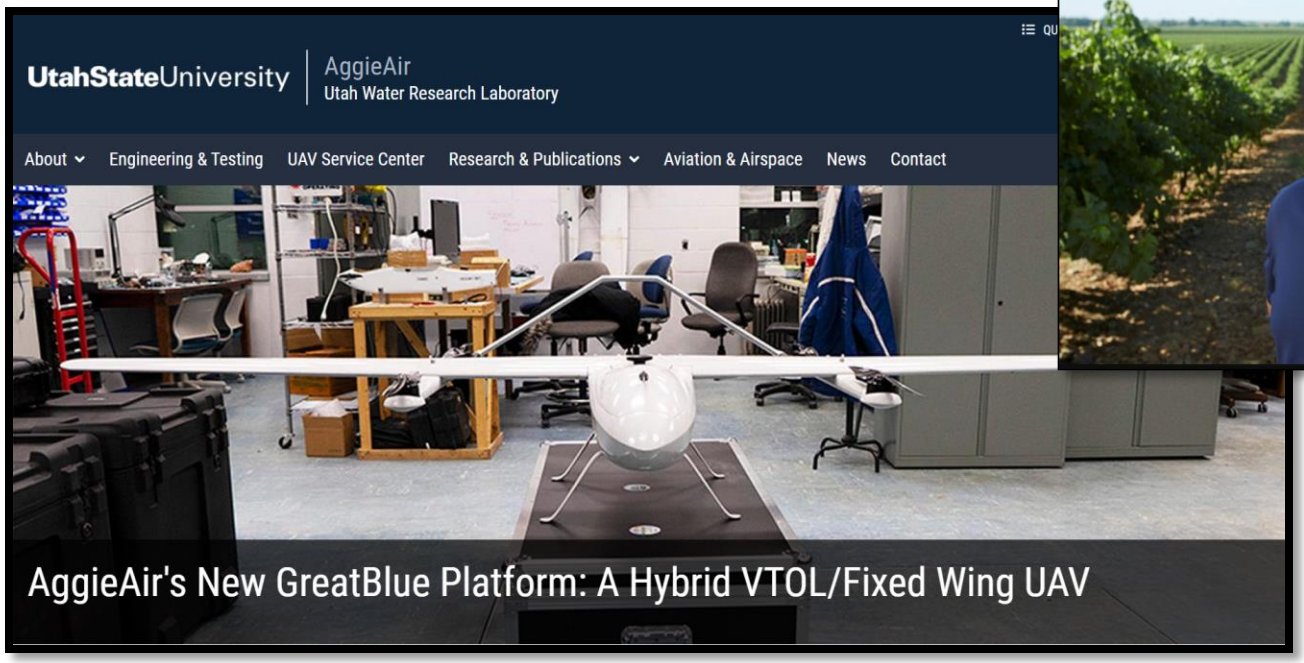
VACAVILLE

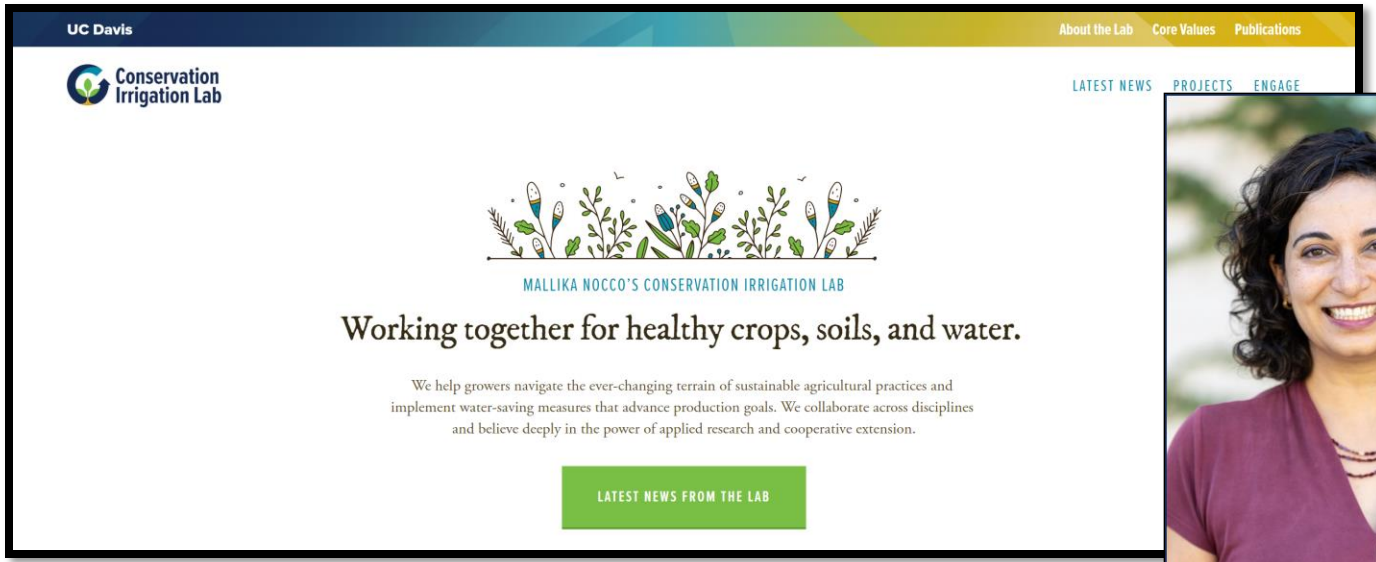
7th leaf
Independence -100%
Silty clay loam soil

RIPPERDAN

8th leaf
Non-pareil-50%,Wood Colony-37%, Supareil-13%


A

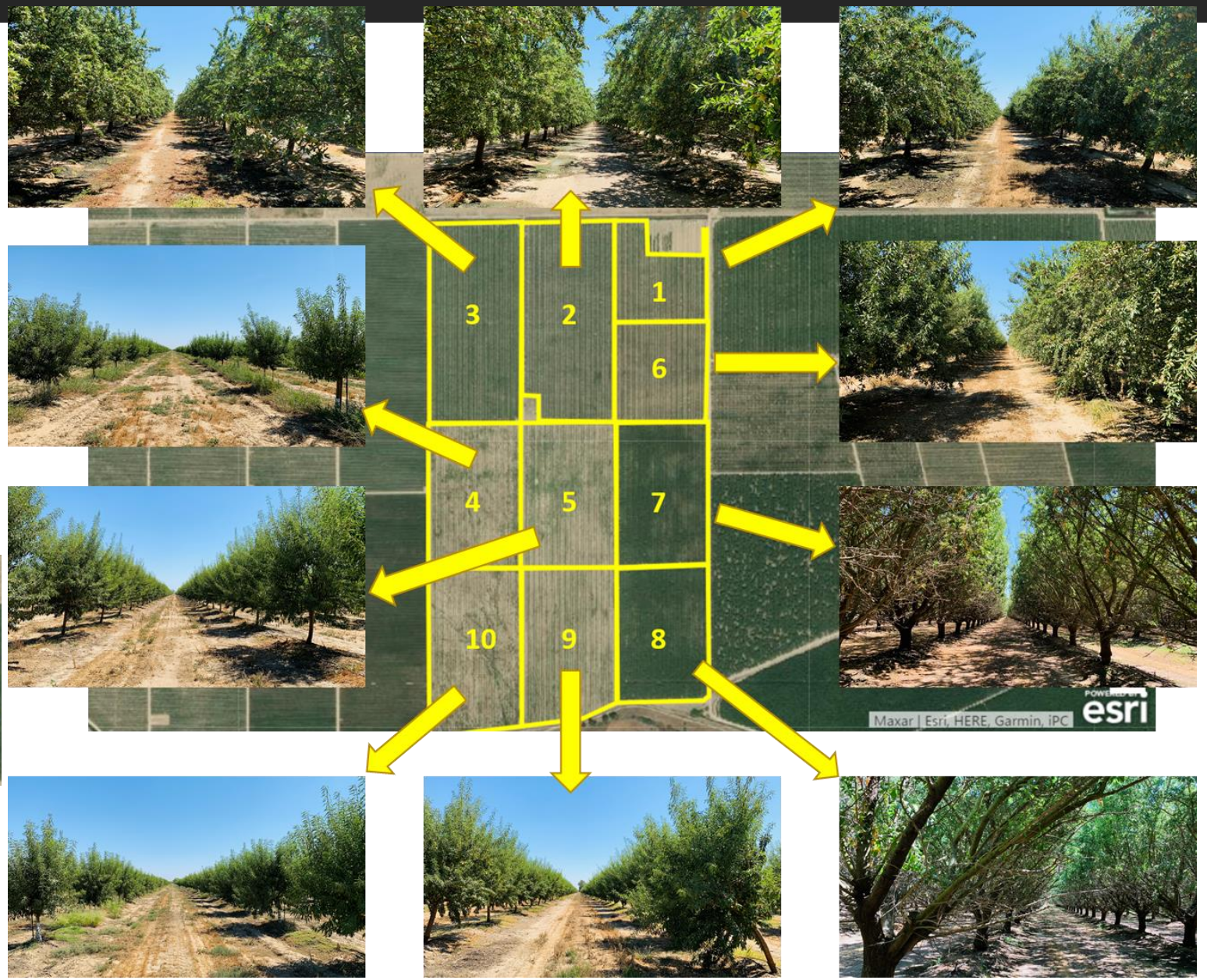

UtahStateUniversity
AggieAir
Utah Water Research Laboratory
About
Engineering & Testing
UAV Service Center
Research & Publications
Aviation & Airspace
News
Contact
AggieAir's New GreatBlue Platform: A Hybrid VTOL/Fixed Wing UAV


UC Davis
About the Lab
Core Values
Publications
Conservation Irrigation Lab
LATEST NEWS
PROJECTS
ENGAGE
MALLIKA NOCCO'S CONSERVATION IRRIGATION LAB
Working together for healthy crops, soils, and water.
We help growers navigate the ever-changing terrain of sustainable agricultural practices and implement water-saving measures that advance production goals. We collaborate across disciplines and believe deeply in the power of applied research and cooperative extension.
LATEST NEWS FROM THE LAB

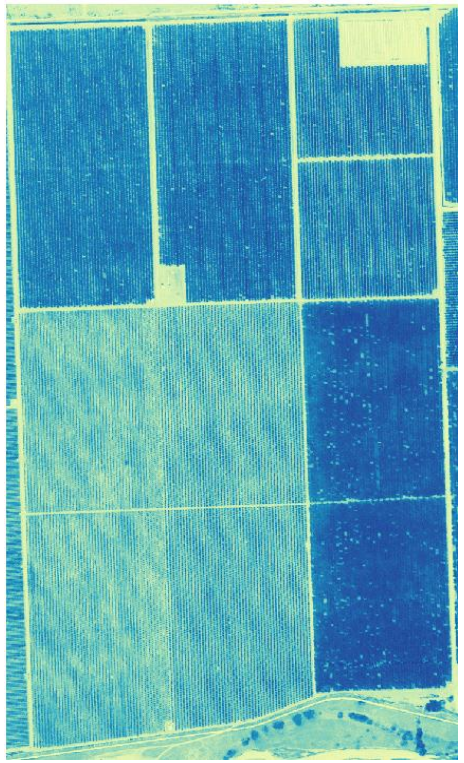
Age Specific Irrigation Management

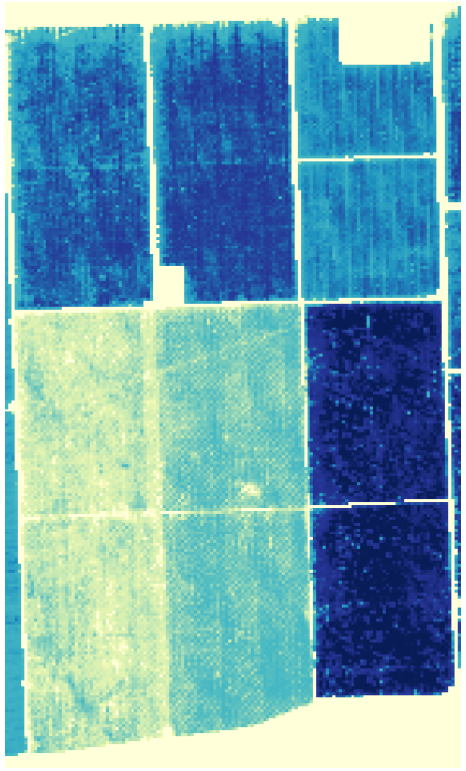
Age:

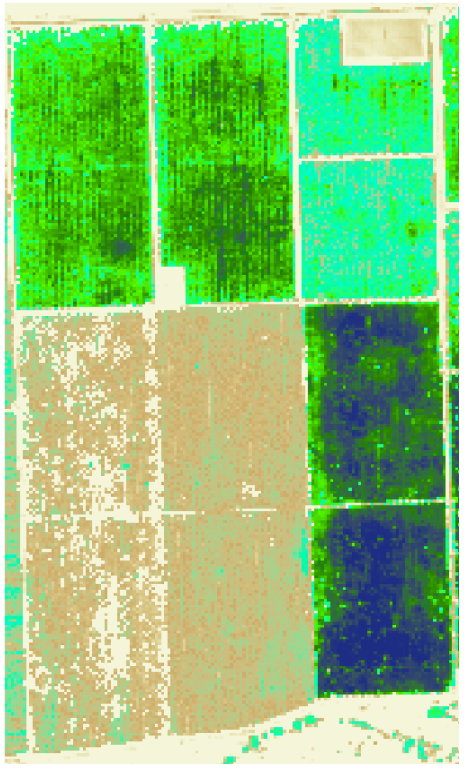
2 years: 4, 5, 9,10
5 years: 1, 2, 3, 6
8 years: 7, 8

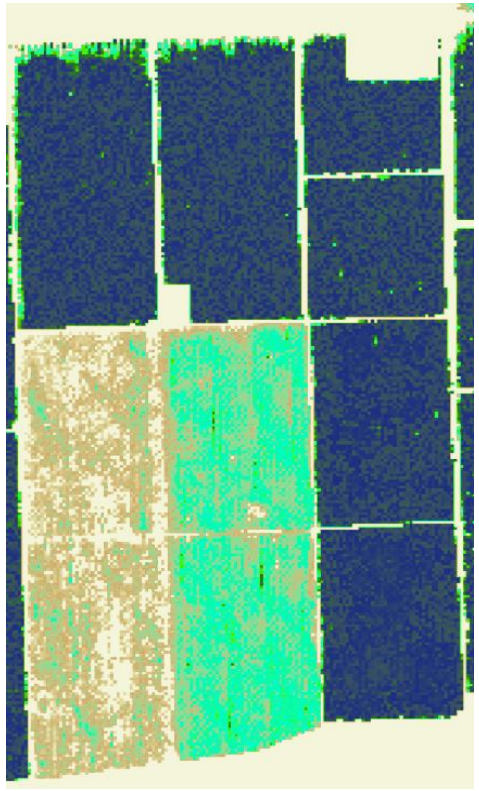


Age Specific Irrigation Management









Age:

2 years: 4, 5, 9,10
5 years: 1, 2, 3, 6
8 years: 7, 8

0 — *NDVI* — 1

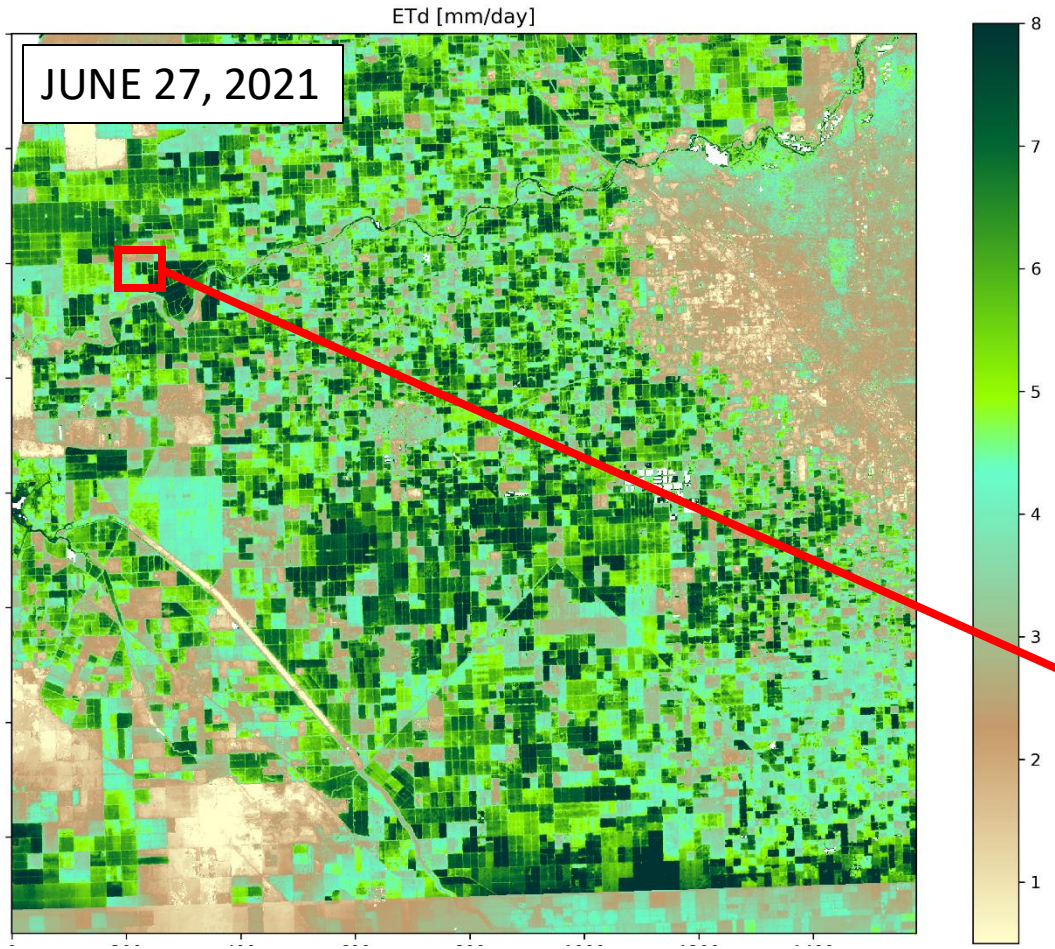
0 — *Leaf Area Index m2/m2* — 6

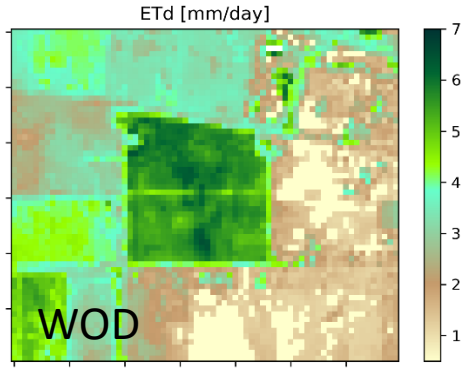
0 — *ET (mm/day)* — 9

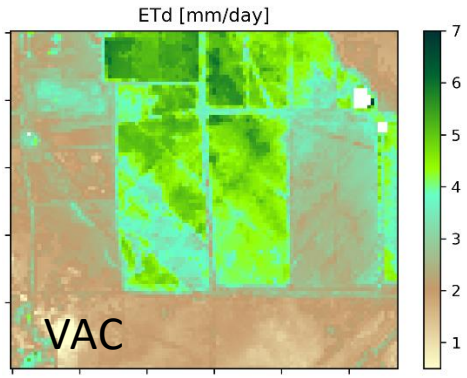
0 — *Transpiration/ET ratio* — 1

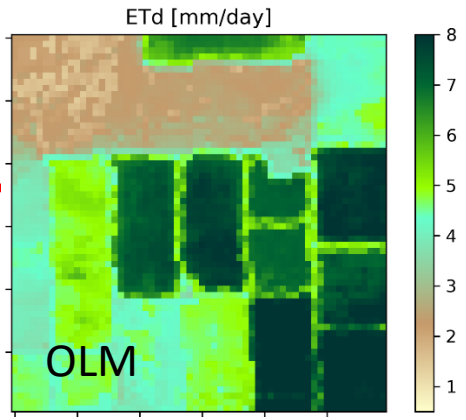
Satellite Remote Sensing

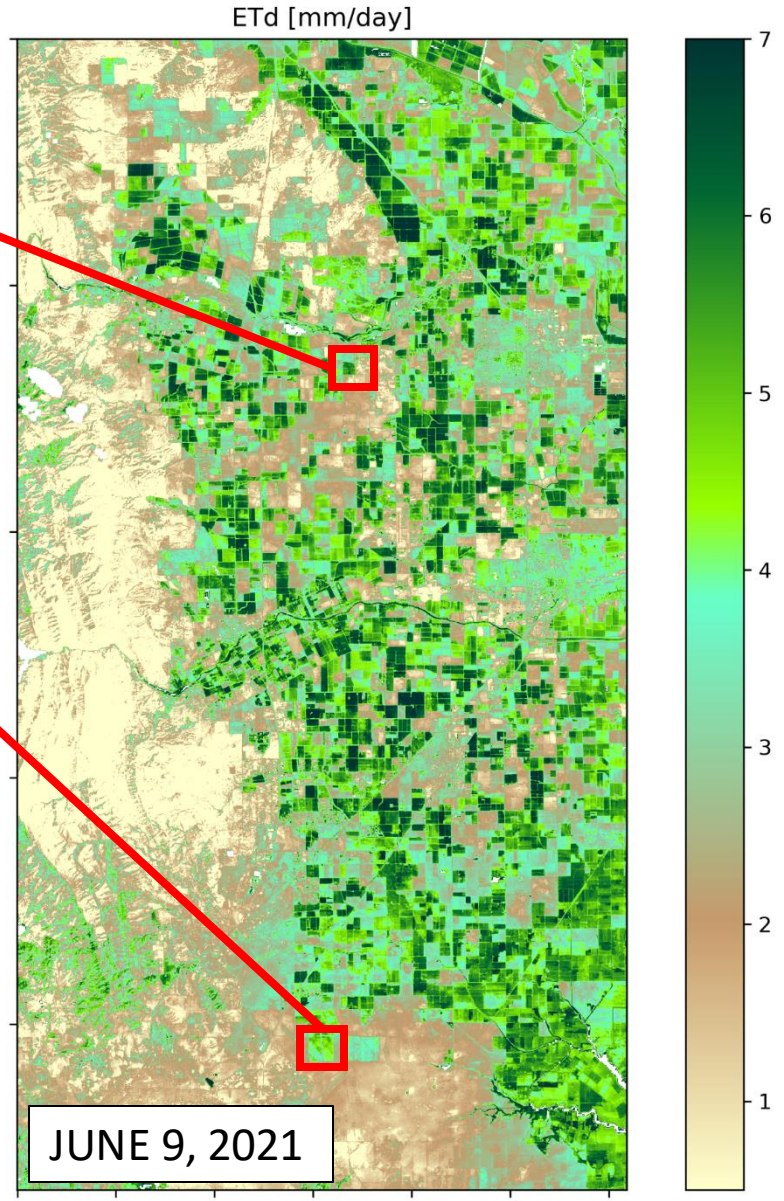
- ET produced for 2020-2023 (OBS = 2021-2023)
- Used newly released Landsat Collection 2 Dataset



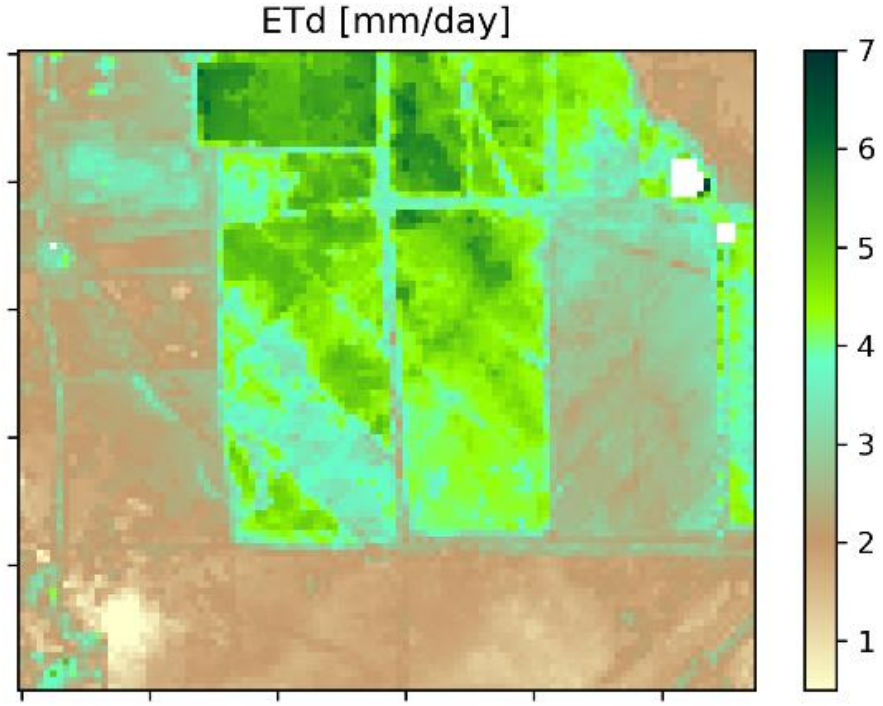


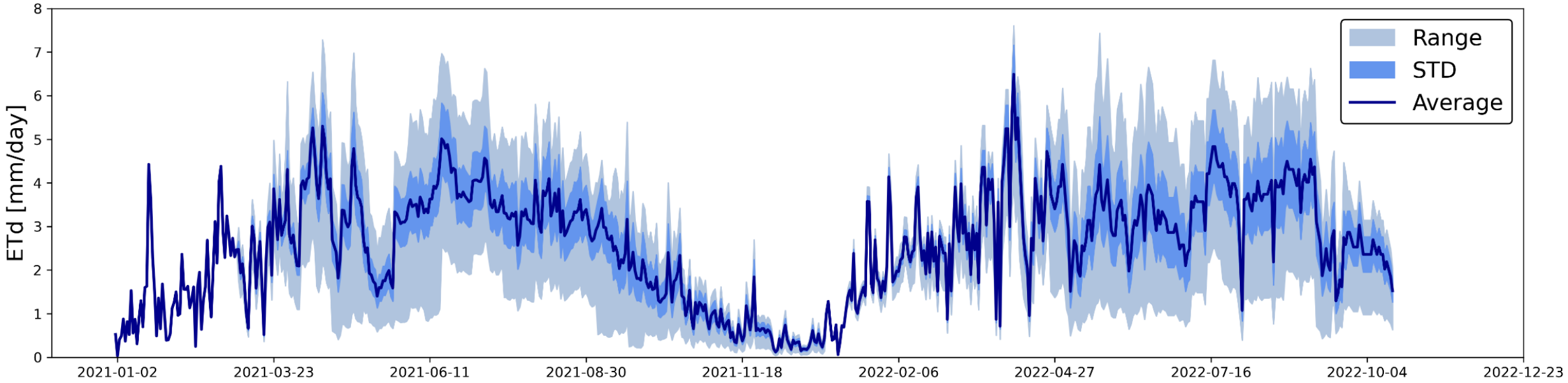






Within site spatial variability



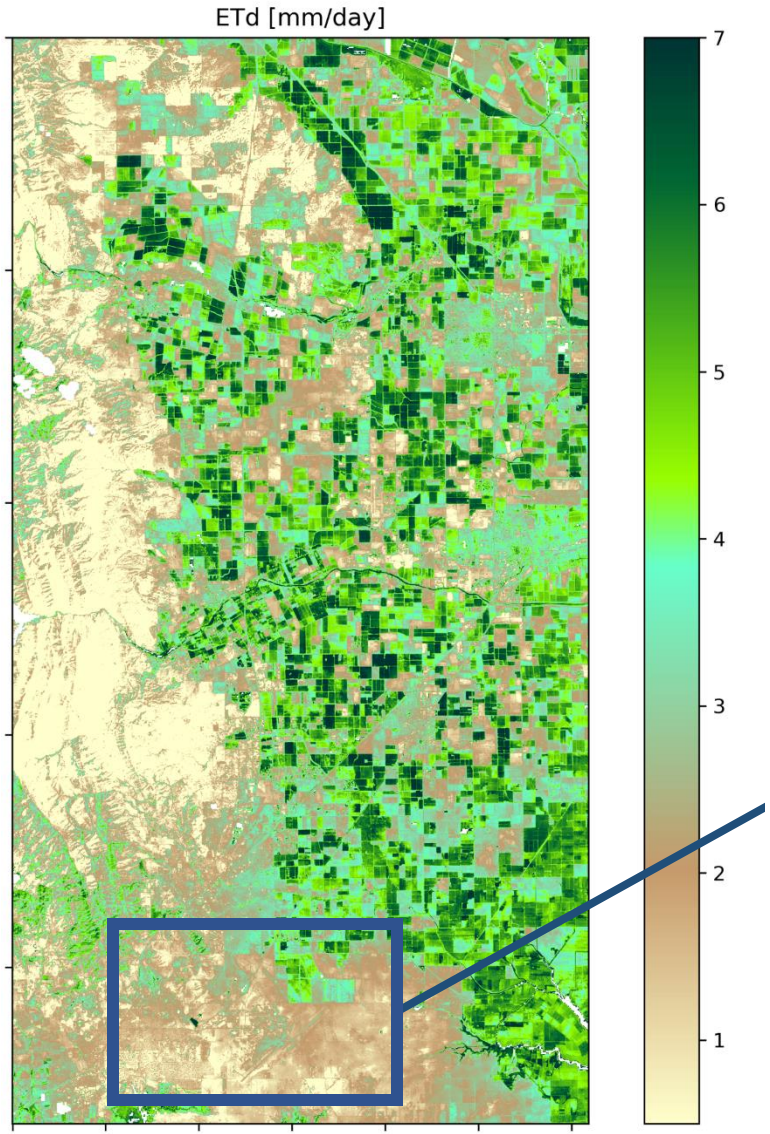


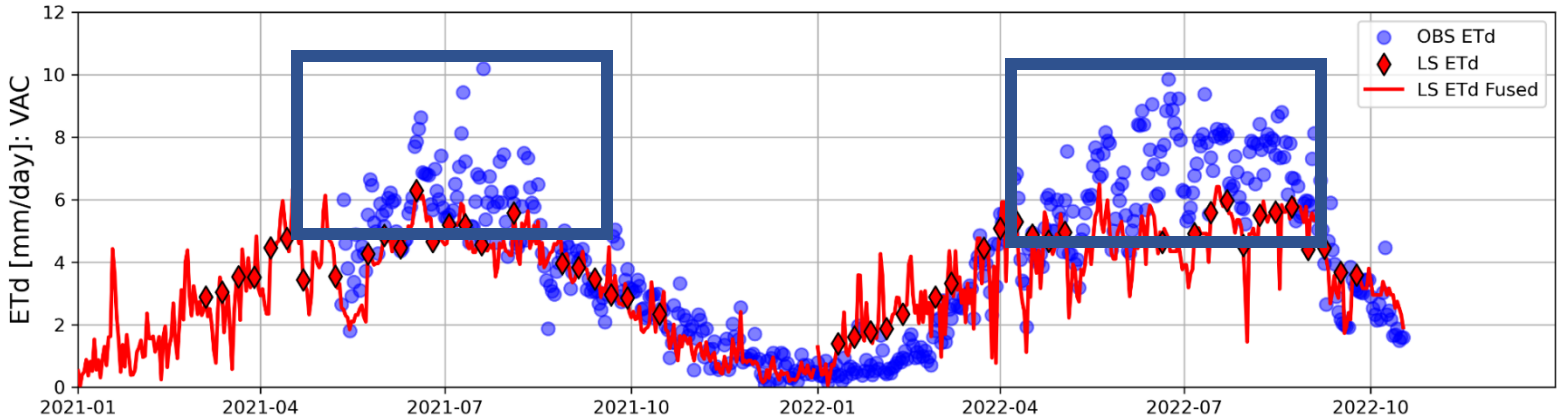
OPENET

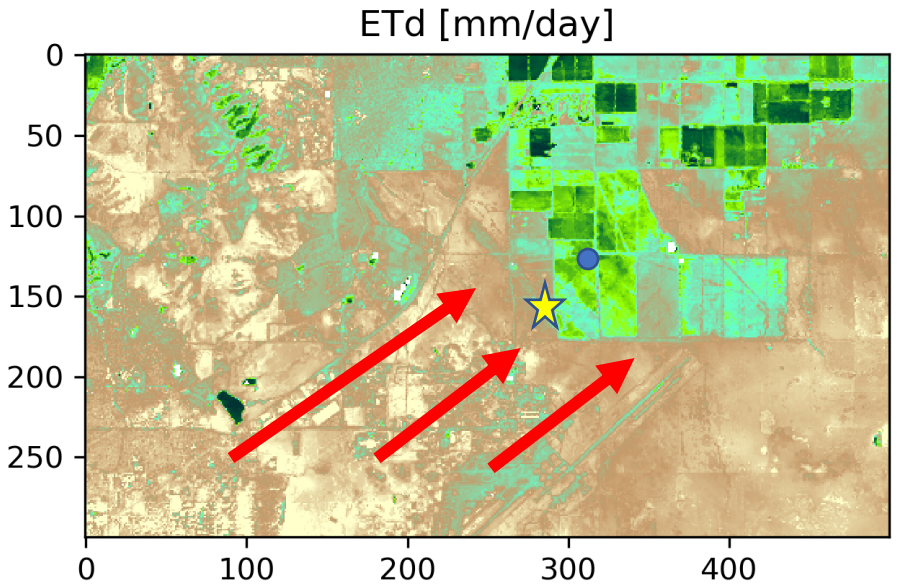
FILLING THE BIGGEST DATA GAP IN WATER MANAGEMENT

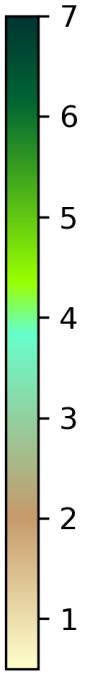
EDF Environmental Defense Fund — Finding the ways that work
NASA
Google Earth Engine
DRI Desert Research Institute
USGS science for a changing world
USDA ars
IHE DELFT
THE WORLD BANK
GWSP Global Water Security & Sanitation Partnership
University of Idaho
Wisconsin University of Wisconsin–Madison
University of Maryland
University of Nebraska Lincoln
California State University Monterey Bay
HabitatSeven

Satellite Remote Sensing- Refining

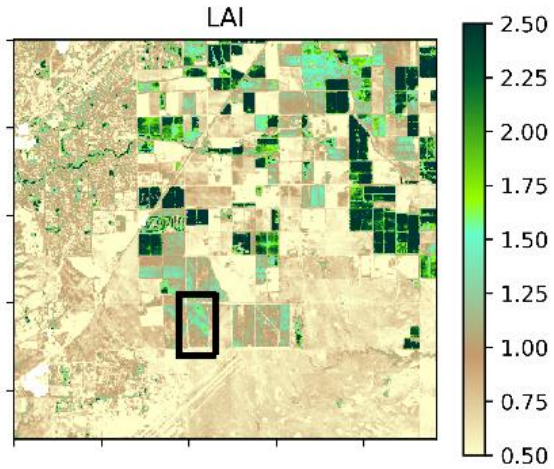


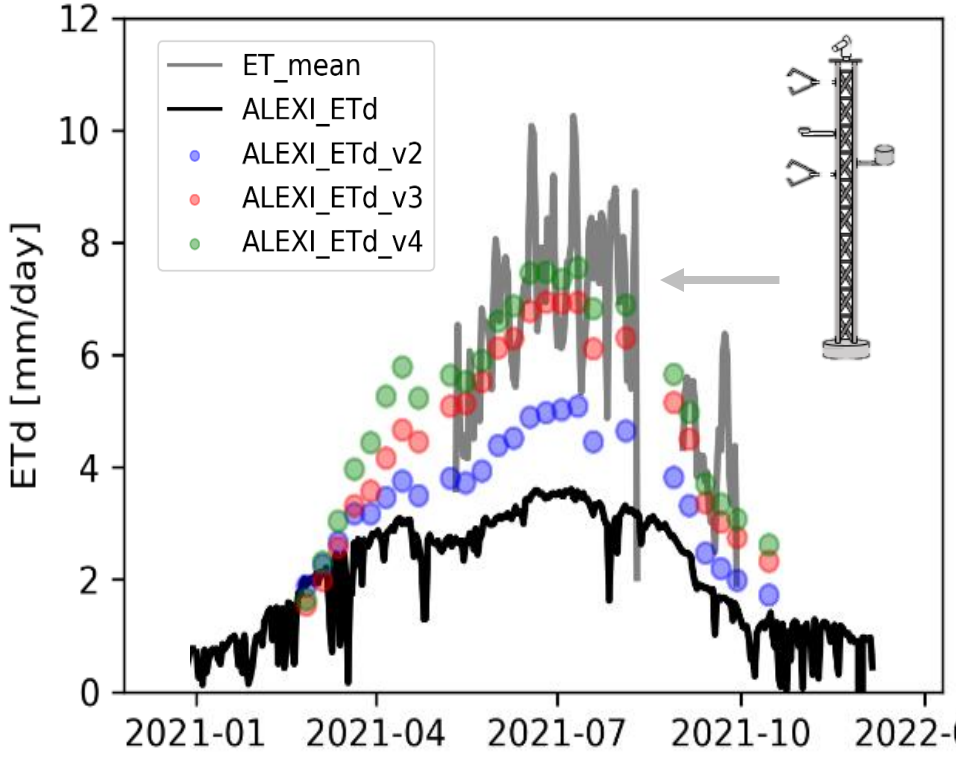


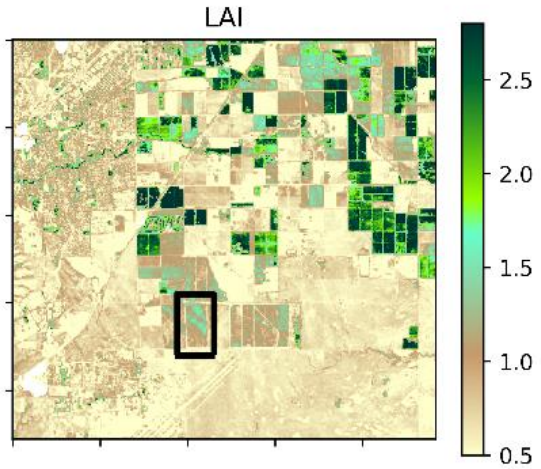


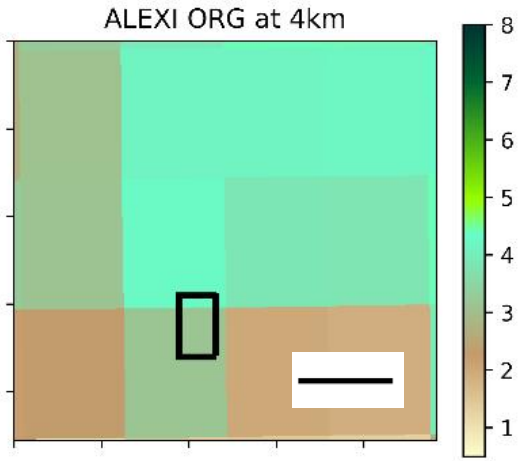


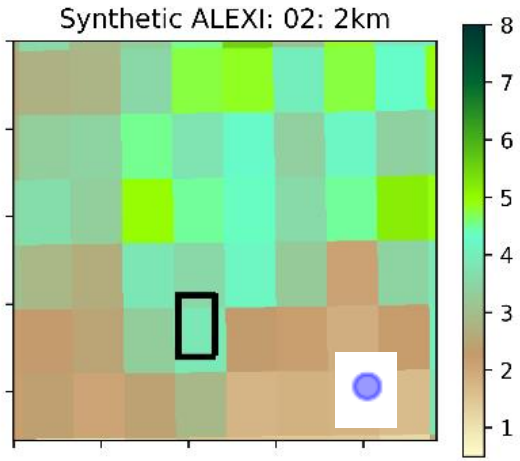
Satellite Remote Sensing- Refining

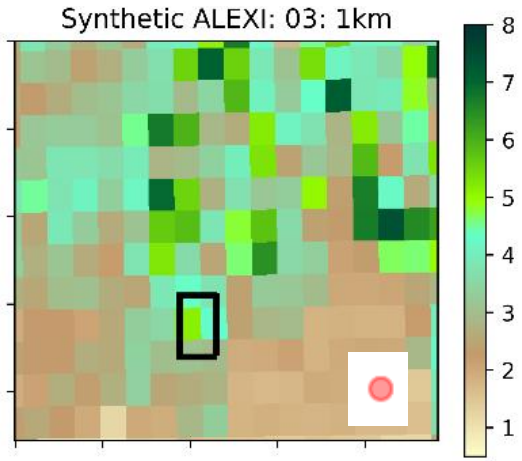


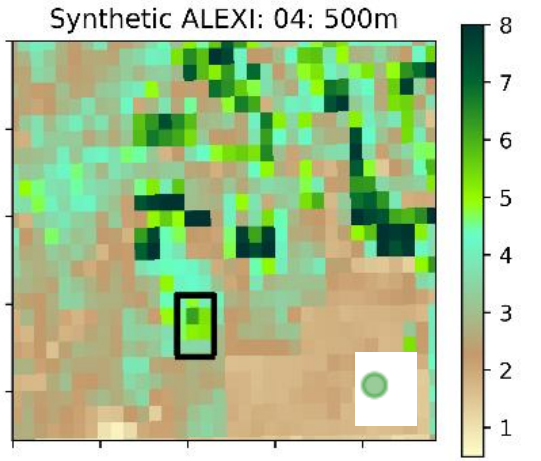








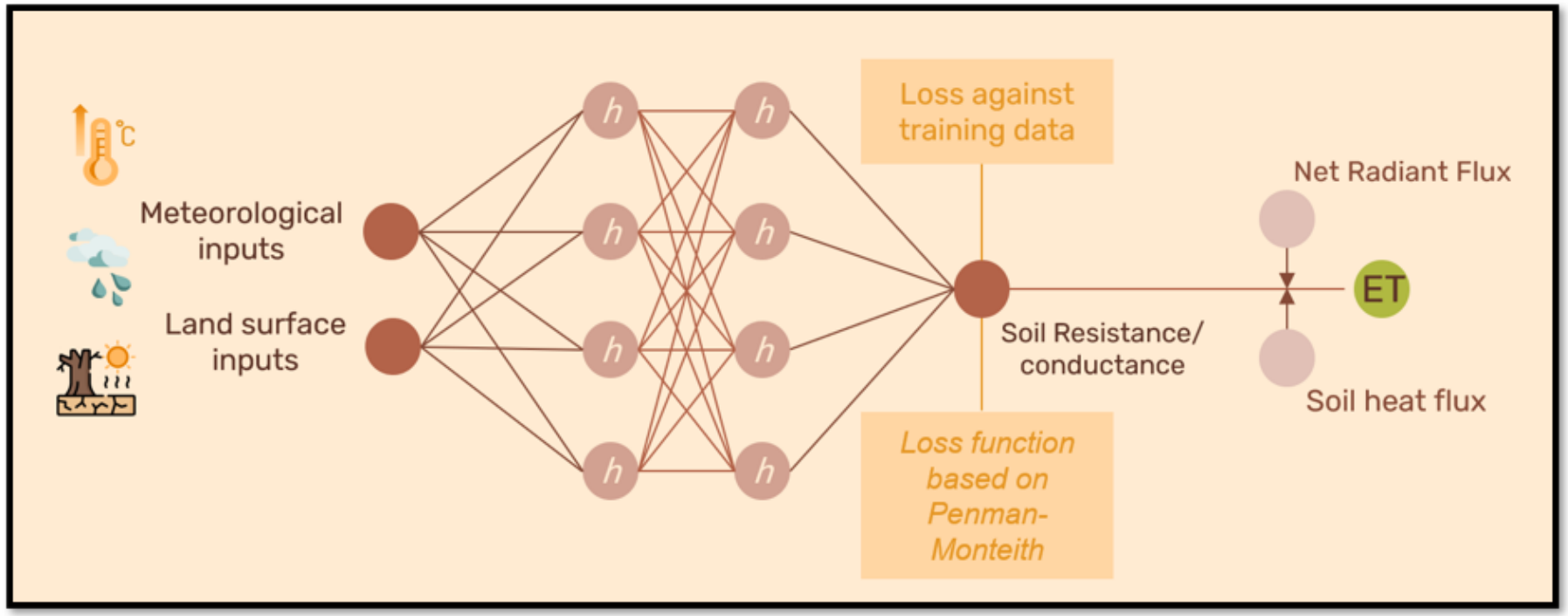


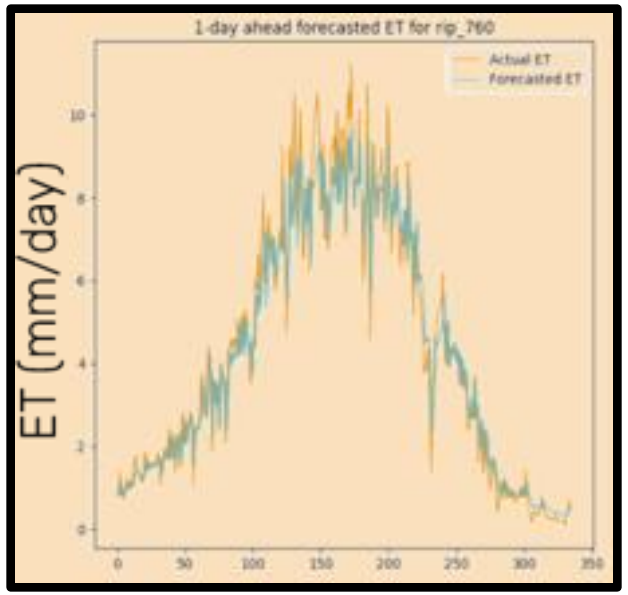


Moving Forward- Developments Beyond 2024

- Site/orchard-specific optimal ET product
- Near-real-time actual ET forecast product

Physics-Informed Neural Networks (PINN)





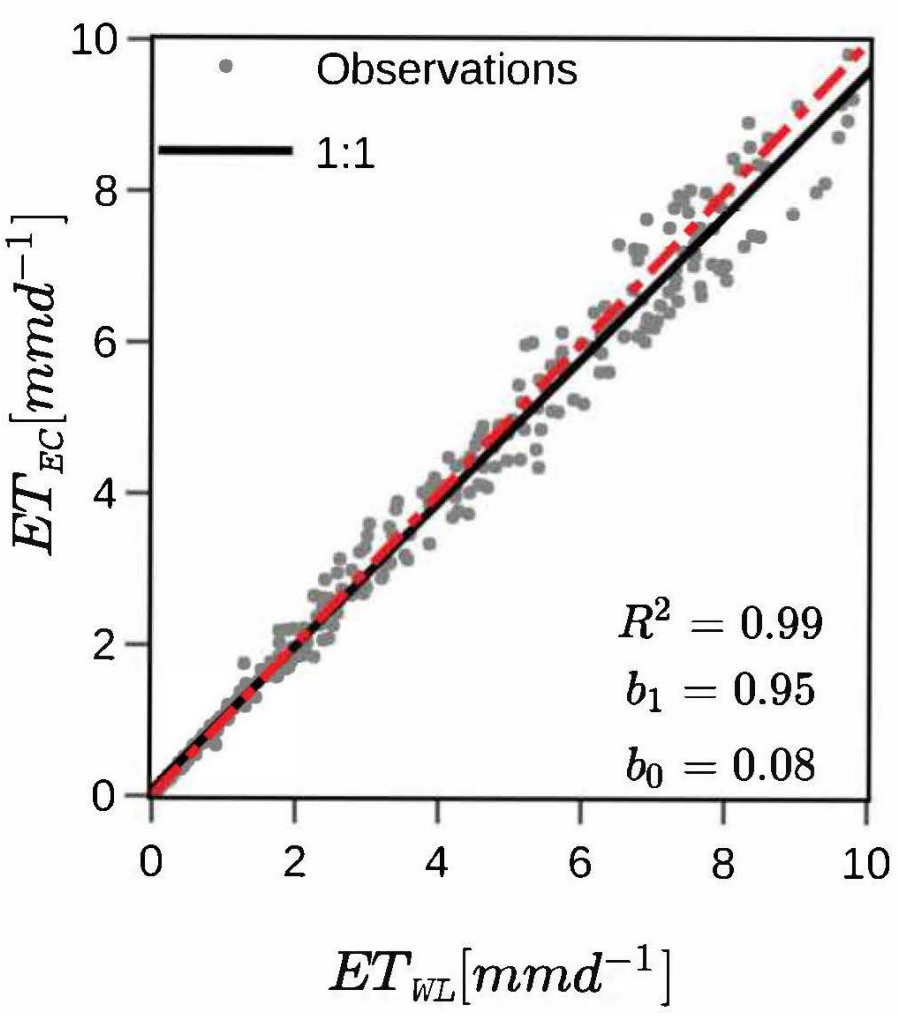
1-, 7-, and 14-Day ETa Forecast

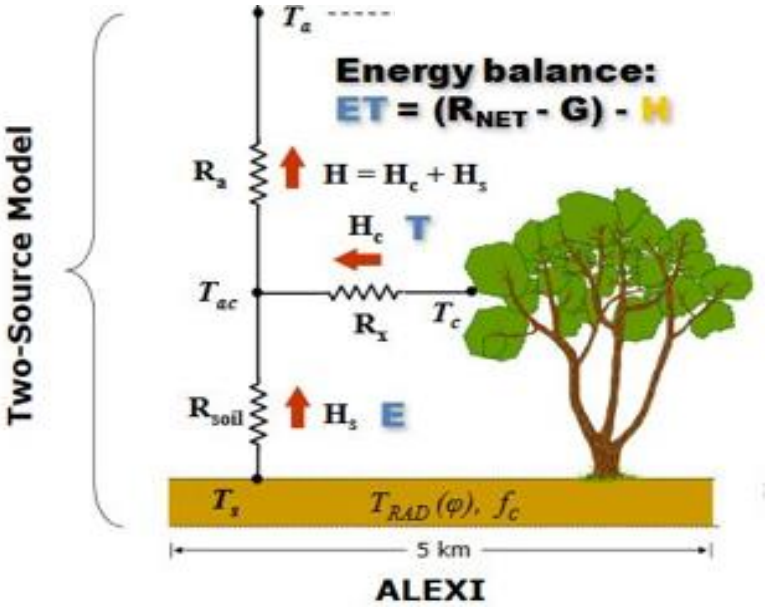
Moving Forward- Developments Beyond 2024

- Site/orchard-specific optimal ET product
- Near-real-time actual ET forecast product
- Data fusion product based on multi-scale input (i.e. ground-based sensors, UAV, satellite)

Complimentary Ground-Based Sensors

ET IRT Wavelet vs. Eddy Covariance





Novel IRT Wavelet method

- Real-time, continuous, ground-based
- Dual stress & ET detection
- Separate tree & cover crop ET

Moving Forward- Developments Beyond 2024

- Site/orchard-specific optimal ET product
- Near-real-time actual ET forecast product
- Data fusion product based on multi-scale input (i.e. ground-based sensors, UAV, satellite)
- ET product adoption trials & Extension strategy deployment

T·REX

Tree crop Remote sensing of Evapotranspiration eXperiment

FUNDING AGENCIES

cdfa

california almonds
Almond Board of California

USDA

INDUSTRY PARTNERS

california almonds
Almond Board of California

Olam

WESTWIND FARMS

planet.

ARABLE

Sumit Sharma

USDA ARS Agricultural Research Service

UC ANR

California State University MONTEREY BAY

COMPLUTIG
EMPRESA DE BASE TECNOLÓGICA DE LA UNIVERSIDAD DE ALCALÁ

UCDAVIS
UNIVERSITY OF CALIFORNIA

UtahState University

NASA
EARTH SCIENCE
APPLIED SCIENCES

AUTOMATION

A Key to Precision Irrigation Management

Connecting the Dots 2023

AUTOMATION PANEL

A KEY TO PRECISION IRRIGATION MANAGEMENT

Andrew Olivos
Olivos

Jacob Christfort
Ranch Systems

James Nichols
Hotspot AG

Guillermo Valenzuela
Wiseconn


california almonds
Almond Board of California
Thank you