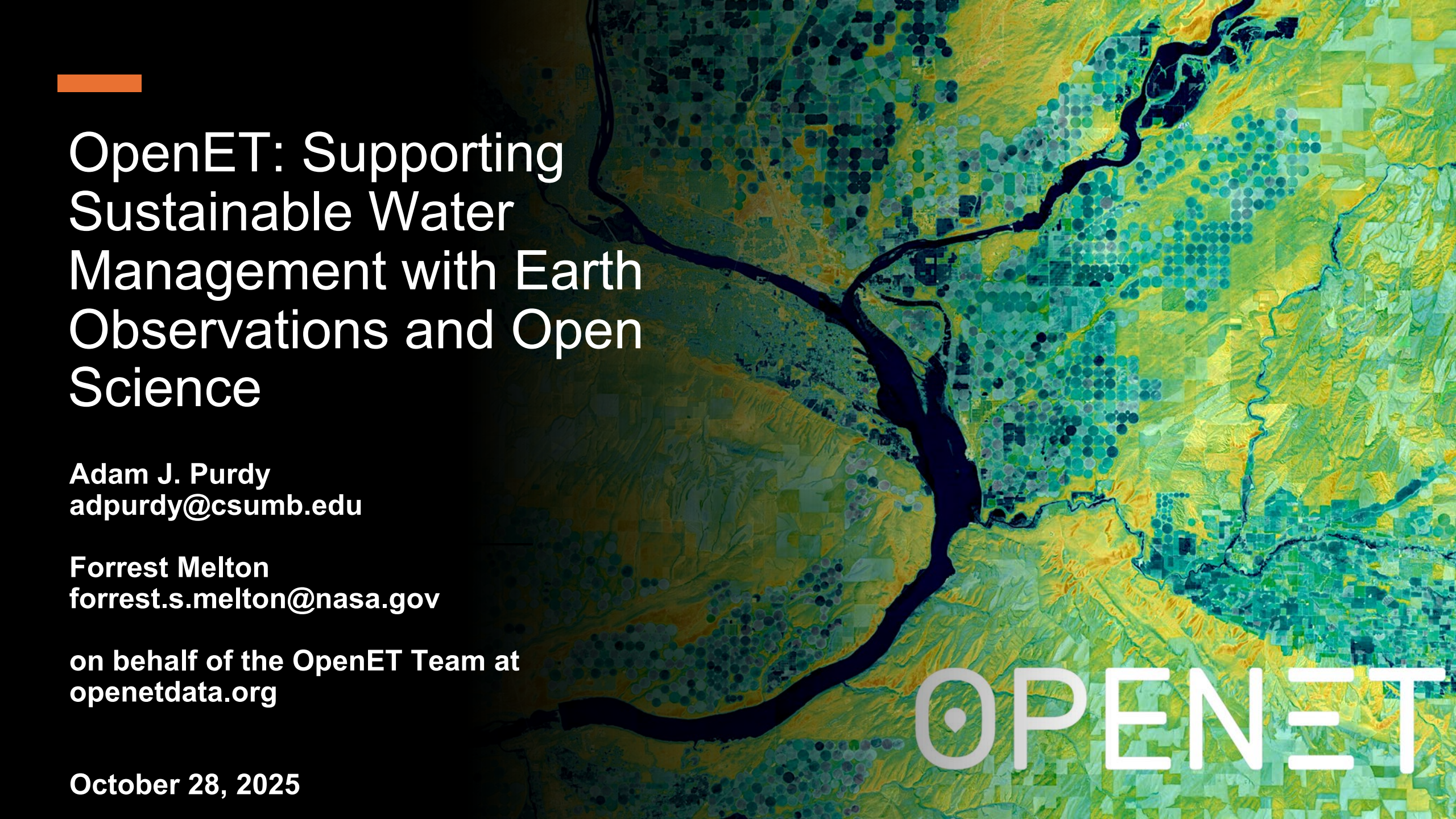




OpenET: Supporting Sustainable Water Management with Earth Observations and Open Science

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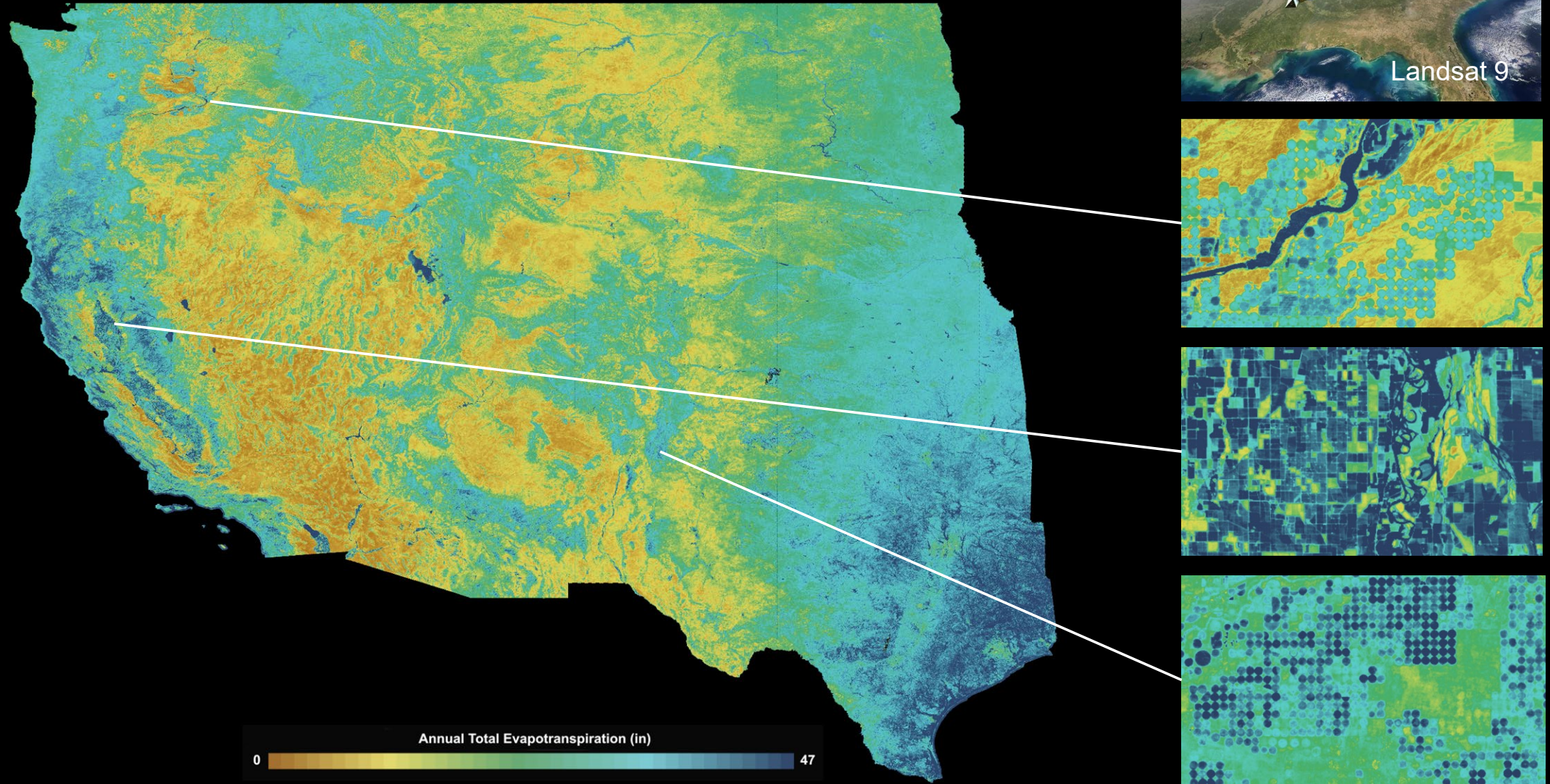
on behalf of the OpenET Team at
openetdata.org

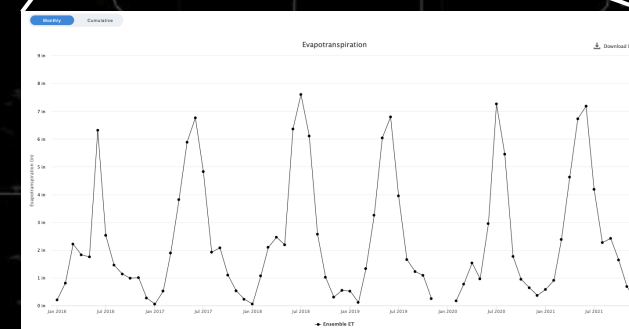
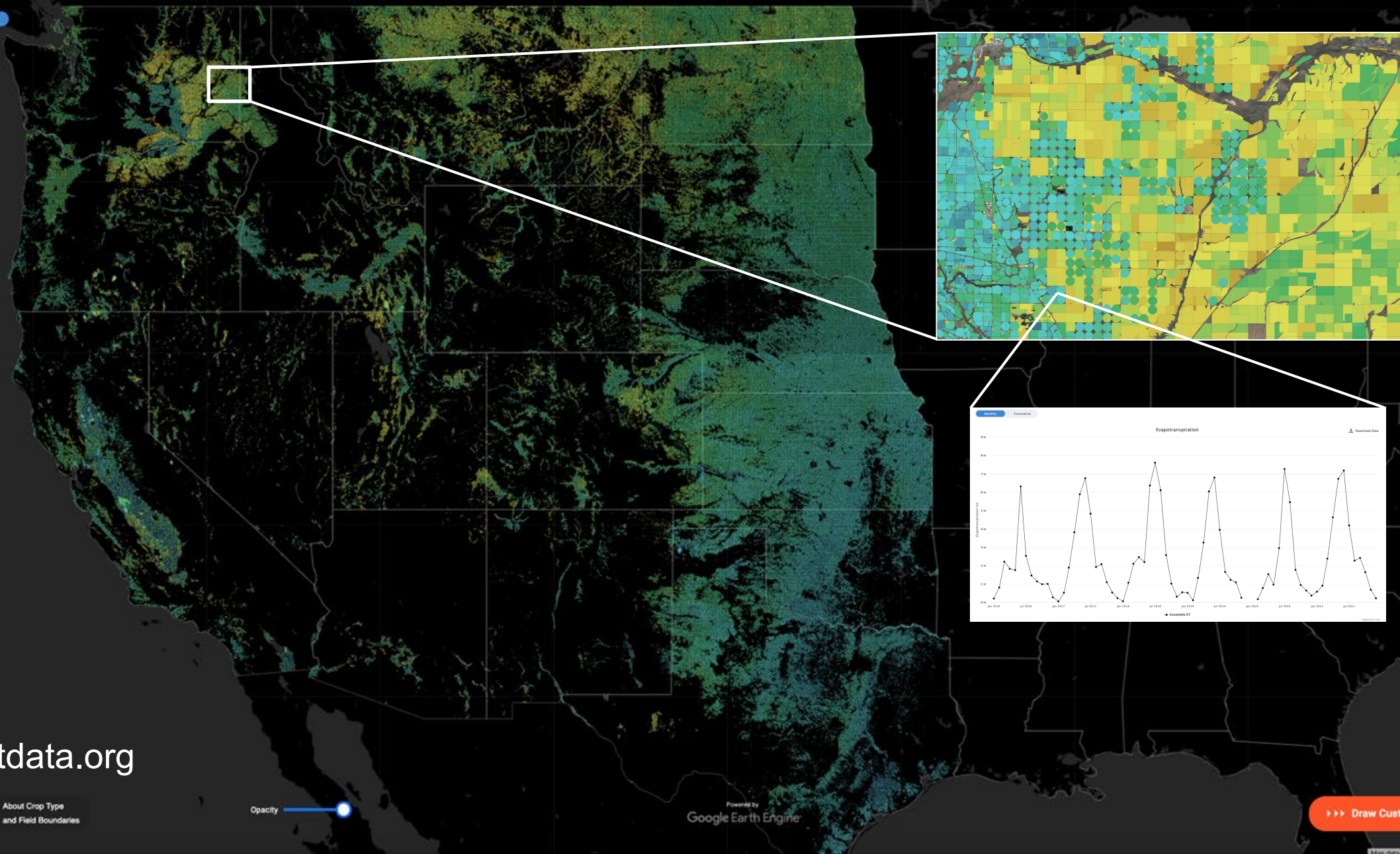
October 28, 2025

OPENET



OpenET: Field-scale Evapotranspiration Data for Water Resources Management





<https://etdata.org>

The OpenET Team

<https://github.com/Open-ET/>

DRI, NASA Ames, Habitat Seven (Multi-model Development, Integration, API, UI)

Charles Morton, Forrest Melton, Chris Pearson, Britta Daudert, Alberto Guzman, Sachiko Sueki, Jordan Harding, Matt Bromley, John Volk, Blake Minor, Justin Huntington

USGS (SSEBop) Gabriel Senay, MacKenzie Friedrichs

Cornell University, USDA ARS (ALEXI/DisALEXI) Yun Yang, Martha Anderson

U. of Nebraska, U. of Idaho (eeMETRIC) Ayse Kilic, Rick Allen, Samuel Ortega

Chapman University, JPL (PT-JPL) Josh Fisher, Gregory Halverson

NASA Ames, CSUMB (SIMS) Forrest Melton, AJ Purdy, Conor Doherty, Alberto Guzman, Lee Johnson, Michael Biedebach, Robin Fishman, Jose Flores

Universidade Federal do Rio Grande do Sul (geeSEBAL) Anderson Ruhoff, Bruno Comini, Leonardo Laipelt

OpenET, Inc. (non-profit) Sara Larsen, Lydia Bleifuss, Will Carrara

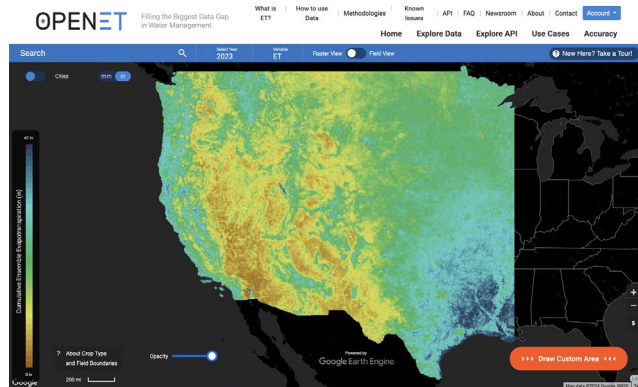
Google Earth Engine Karin Tuxen-Bettman



OPENET

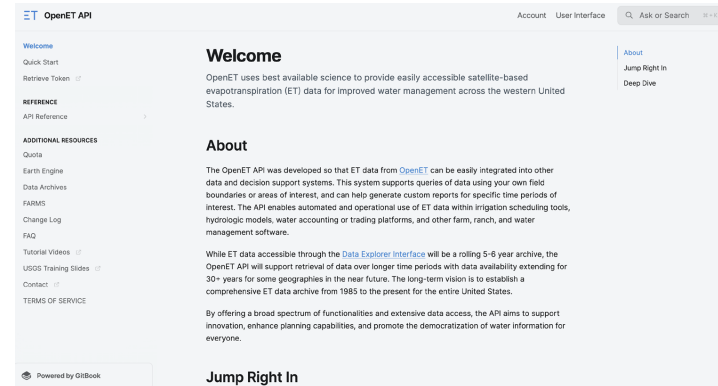


Data Access and Open Science



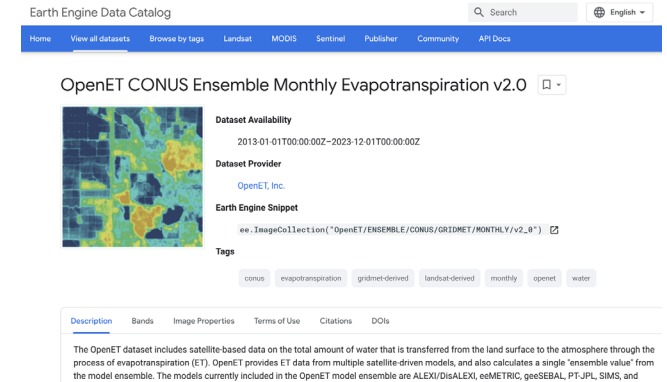
OpenET Data Explorer

<https://explore.etdata.org>



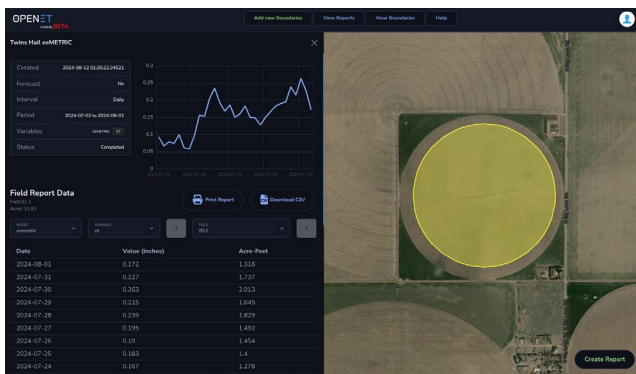
OpenET API

<https://openet.gitbook.io/docs>



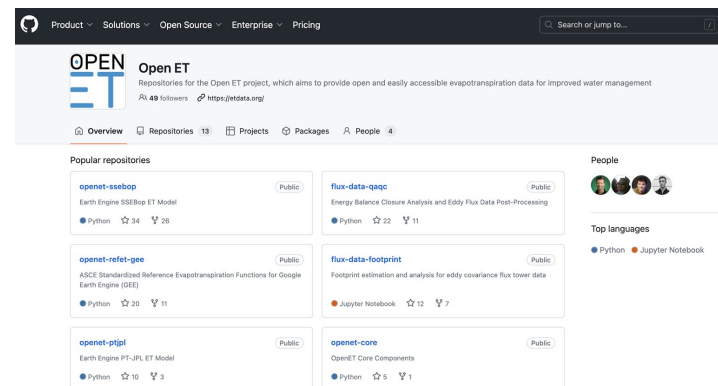
OpenET GEE Data Catalog

<https://developers.google.com/earth-engine/datasets>
(search for 'OpenET')



OpenET FARMS User Interface

<https://farms.etdata.org>



OpenET Open Source Repositories

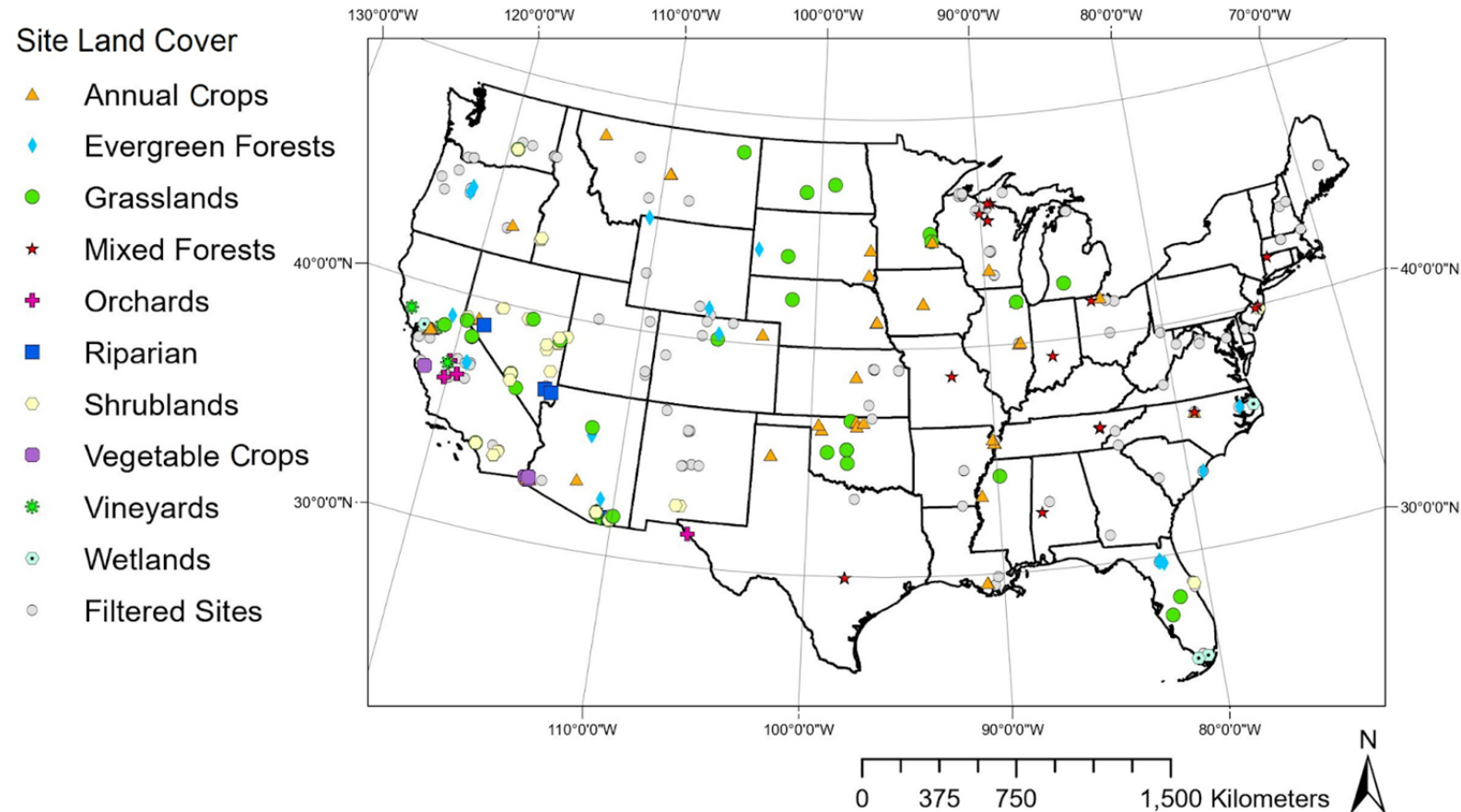
<https://github.com/Open-ET/>

- >12,300 users
- >620,000 data retrievals
- Backed by dedicated science and software engineering teams

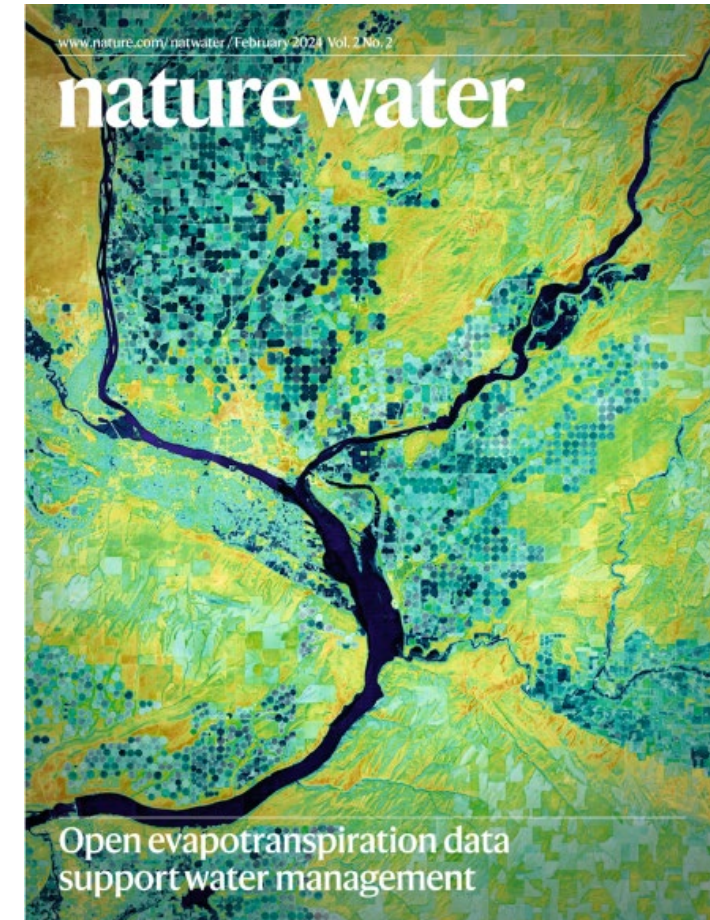
Stakeholder-Defined Applications & Accuracy Needs

Application	Baseline Accuracy	Optimal / Threshold Accuracy	Time of Use	Ensemble of Values or One Value?
Irrigation scheduling	+/- 25% daily	+/- 10-15% daily	1-3x per week	One value
Water accounting / demand projections	+/- 20% monthly +/- 15% annual	+/- 15%	Monthly to annual	Ensemble
Drought monitoring / impact assessment	+/- 20% monthly +/- 15% annual	+/- 15%	Monthly or seasonal reports	One value
Water transfers	+/- 20% monthly +/- 15% annual	+/- 10%	Monthly and annual reports	One value
Water budgets	+/- 15% annual	+/- 10%	Annual reports	One value
Calibration of groundwater models	+/- 15% annual	+/- 15%	Retrospective analyses	Ensemble
Conservation planning	+/- 15% annual	+/- 15%	Retrospective analyses	Ensemble
Water rights admin / Regulatory compliance	+/- 20% monthly +/- 15% annual	+/- 5-10%	Monthly and annual reports	One value

Building trust: Model Intercomparison and Accuracy Assessment



- Evaluation included 148 flux tower sites (70 ag sites)
- Avg. daily energy balance closure was 0.88 during the growing season and 0.86 during the non-growing season (Volk et al., 2023)



Volk et al., Nature Water, 2024

OpenET Ensemble Value: Croplands

Accuracy Summary for Croplands for the OpenET Ensemble ET Value						
Time Period	Slope	Mean Bias Error)	Mean Absolute Error	Root Mean Squared Error	r-squared	Mean flux tower ET
Water Year: 14 sites / 48 total water years	0.93	-71.6 mm (-7.0%)	91.3 mm (8.9%)	100.5 mm (9.8%)	0.88	1024 mm
Growing Season: 38 sites / 151 growing seasons	1.0	-10.1 mm (-1.7%)	80.3 mm (13.2%)	92.7 mm (15.2%)	0.88	609.5 mm
Monthly: 45 sites / 1,682 months	0.92	-5.3 mm (-5.8%)	15.8 mm (17.3%)	20.4 mm (22.4%)	0.90	93.7 mm
Daily: 49 sites / 4,804 days	0.86	-0.35 mm (-10.0%)	0.83 mm (23.6%)	1.09 mm (31.1%)	0.80	3.5 mm

Slope: Measure of overall bias; 1.0 is perfect

Mean Bias Error (MBE): Measure of bias; 0.0 is perfect

Mean Absolute Error (MAE): Measure of expected error; 0.0 is perfect

Root Mean Squared Error (RMSE): Measure of expect error with additional weight for outliers; 0.0 is perfect

Volk et al., Nature Water, 2024



OpenET in the Colorado River Basin

- The four Upper Basin States unanimously adopted OpenET (eeMETRIC model) as the basis for quantifying consumptive use across the Upper Colorado River Basin
- First time the Upper Basin had a consistent basin-wide measure of ET and consumptive
- Landsat's long-term data record is key → OpenET data (1991-2024) help guide drought response planning for 2026 and beyond.
- OpenET data support evaluation of voluntary, incentive-based water conservation programs
- OpenET is anchoring key regional tools including:
 - Utah Colorado River Accounting and Forecasting System
 - Western States Water Council Western Conservation Assessment Tool

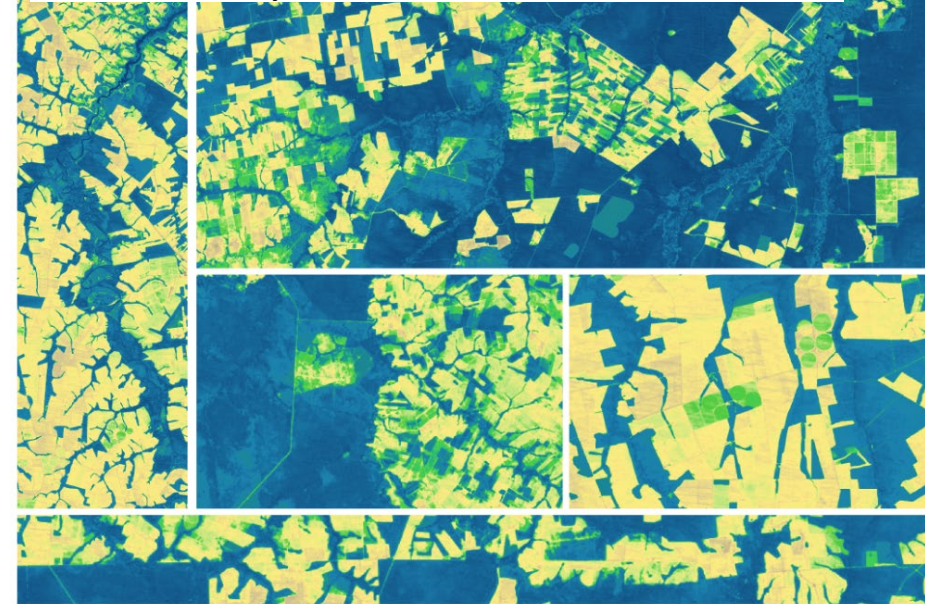


Scaling OpenET for International Applications

- OpenET Brazil, launched in April 2024, advances irrigation planning, water-use transparency, drought adaptation, and sustainable agriculture/forestry practices
- Led by Anderson Ruhoff at the Federal University of Rio Grande do Sul
- Open-source software & cloud-computing platforms (e.g. GEE) enable global adoption through locally-led geographic expansion and application development
- Persistent cloud cover in the Amazon Basin (as well as regions in the U.S.) underscores the need for future TIR constellations to improve ET mapping and assess deforestation impacts on water fluxes and hydrologic cycling.



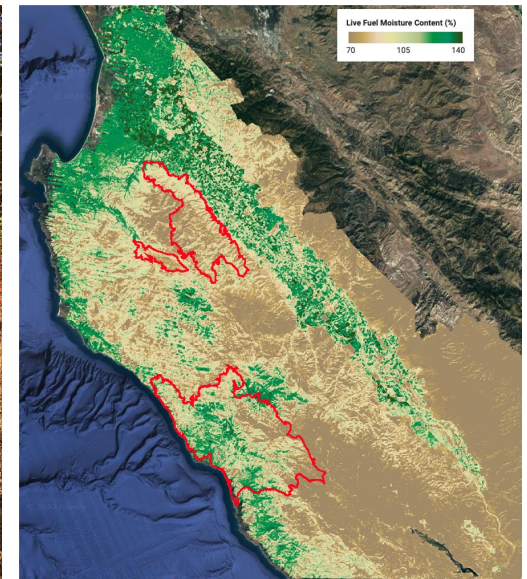
Federal University of Rio Grande do Sul/Anderson Ruhoff



Federal University of Rio Grande do Sul/Leonardo Laipelt

Wildfire Risk & Forest Management

- OpenET data capture vegetation water stress and support evaluating hydrologic impacts of forest treatment programs.
- Ongoing work is also focused on using OpenET to map live fuel moisture at 30 m resolution. Live fuel moisture is an important indicator of wildfire risk and fire behavior.
- The NASA FireSense program is investing in the use of OpenET data in wildfire risk mapping and support of wildland fire response.
- Current research is focused on developing assessment tools for forest treatment programs leveraging OpenET data.



Key Lessons Learned and Takeaways

- OpenET illustrates how satellite data and open science can advance hydrologic mapping *and* sustainable water management at continental scales
- User-driven co-development of data products and focused use cases are essential to transforming data into actionable information.
- Strong interagency and public-private partnerships, with backing from federal, state and philanthropic support, are key to *scaling* and *sustaining* systems like OpenET
- Landsat NEXT and long-term data continuity are required to maintain consistent, high quality observations.
- Coordinated, international satellite TIR/VSWIR constellations (e.g., Landsat, ECOSTRESS, SBG, Trishna, LSTM) are critical to fully meeting global ET user community requirements for latency, consistency and accuracy.



Questions?

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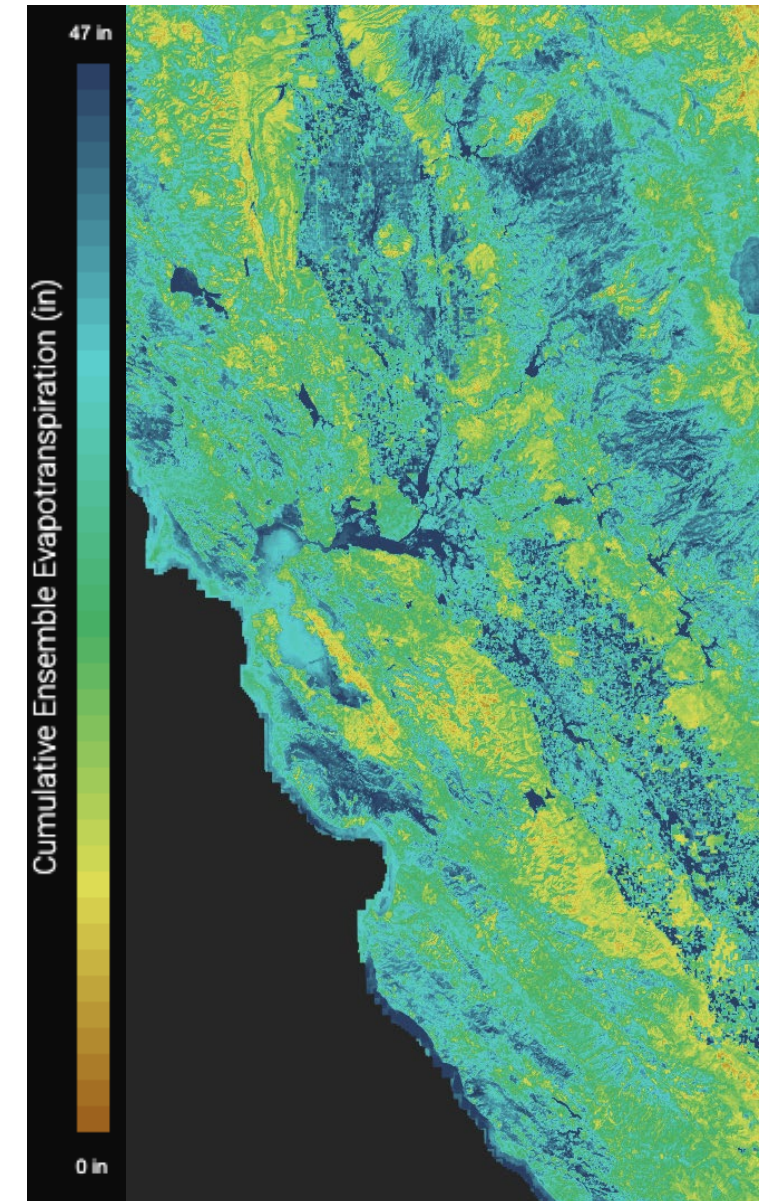
Examples of OpenET Applications

- Utah, Wyoming, Colorado, New Mexico, Arizona, Nevada and California are using OpenET to save water and plan for future drought events in the Colorado River Basin
- Kansas, Oklahoma and Texas are using OpenET to support farmers that rely on irrigation from groundwater and to extend the life of the Ogallala Aquifer
- Nebraska uses OpenET to improve groundwater management and water accounting in the Twin Platte District
- Montana and Idaho use OpenET to quantify consumptive use for water accounting
- Nevada and Oregon use OpenET for groundwater management in locations including Diamond Valley (NV) and the Harney Basin (OR)
- California uses OpenET for water use reporting, groundwater management, and irrigation scheduling
 - Used by multiple groundwater sustainability agencies in water budgeting
 - \$29 million in savings for farmers through use in quantification of water use in the Delta
 - \$127.5 million in projected value to almond farmers through use in irrigation management



Supporting Implementation of the Sustainable Groundwater Management Act in California

- OpenET data used by Groundwater Sustainability Agencies (GSAs) and consultants across California to calibrate groundwater models and quantify historic and current rates of groundwater use
- Archive of monthly ET data made available for California from October 1999 to present in partnership with CA Department of Water Resources
- Gridded daily ET rasters available statewide for select years
- Freely available open data services to generate custom ET data summaries for GSAs and consultants



Supporting Data-Driven Irrigation Management

- OpenET agricultural partners in Oregon's Harney Basin and California's Central Valley and Salinas Valley have used OpenET to develop data-driven irrigation management systems
- ET-based irrigation management has been demonstrated to reduce applied water by 15-27% with substantial cost savings to farmers for electricity for groundwater pumping, water and fertilizer (due to reduced leaching of fertilizer) (Cahn et al., 2024)
- Agricultural producers, ag tech companies and extension specialists have integrated the OpenET data into irrigation and nutrient management tools for use across the western U.S.
- Over the past 12 months, ~40% of the data retrievals from OpenET have been for the purpose of irrigation management

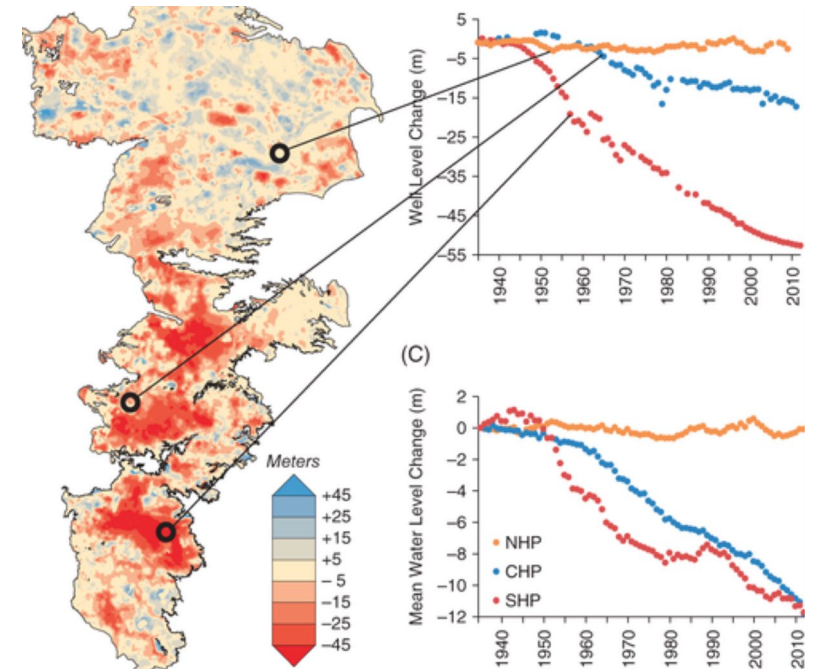


Supporting Solutions for the Ogallala Aquifer

- Key regions of the Ogallala Aquifer across Kansas, Oklahoma and Texas have experienced sustained groundwater declines. **Well production capacity in some regions has dropped by up to 75%** harming farmers in the region.
- **Pumping reductions of ~5-30% can stabilize aquifer levels** in many regions and extend the life of the Ogallala Aquifer.
- Kansas State leading USDA Sustainable Ag Systems award to support agronomists, agricultural extension specialists and farmers in KS, OK and TX in using OpenET to design and **evaluate a range of cost effective strategies for stabilizing groundwater levels** across the Ogallala.



- Comparisons against flow meters across Kansas showed strong agreement: 4.9% MBE, 0.2 mm/day MAE for the ensemble ET value (Zipper et al., 2024)
- Commercial companies in the region are developing sensor packages to support data-driven irrigation management, but use freely available data from the OpenET to provide the historical ET data for each farm to inform irrigation management and project water needs for the season.



Groundwater declines across the Ogallala Aquifer from Hackert et al. (2015), DOI: 10.1111/gwat.12350

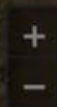
2024 OpenET User Applications Conference

- 249 attendees
- 156 different organizations
- 32 different states
- 3 individual countries



Additional independent accuracy assessments

Study	Crop Type and Location	Key Findings (all studies used eddy covariance to evaluate OpenET and found that the Ensemble ET value performed best)
Sabiston et al. (2024)	Alfalfa, New Mexico	● Ensemble ET value seasonal difference of 48 mm (1.89 in, or -3.6%) ● Differences for individual models all within $\pm 11.4\%$.
Tawelbeh et al. (2024)	Pecans, New Mexico	● Ensemble ET value at monthly timestep $\rightarrow$ R-squared value of 0.95 with a 2% mean relative difference and standard error of 15 mm/month (0.59 in/month) ● Individual models also performed well in this study; mean absolute differences ranged from -8.3% to 11.2%.
Knipper et al. (2024)	Almonds, California	● Ensemble ET value at daily timestep $\rightarrow$ R-squared value of 0.73 and a MAE of 0.95 mm/day (0.04 in/day or 15.7%) ● Models had difficulty capturing some types of short-term variability in ET at these sites, such as the rapid decline in ET preceding almond harvest when irrigation is shut off completely.
Dhungel et al. (2024)	Citrus, California	● Ensemble ET value at daily timestep $\rightarrow$ 30% larger on average than both the flux tower ET and the total amount of water applied for irrigation ● r-squared value of 0.71; RMSE of 1.16 mm/day (0.046 in/day). ● Study noted that most of the difference occurred during the spring (approx. day of year 60 to 120).



LOCATION SEARCH

North Ogden

Evanston

Lyman

Mountain View

OGDEN

Layton

Morgan

Coalville

Bountiful

SALT LAKE
CITYWest
Wendover

Upload Shapes

Click here to upload a zipped shapefile or a geojson file.

Draw your Own

Draw your own field boundaries using our drawing tools.

Select Existing

Choose your fields from the existing OpenET boundaries.

Eagle
Mountain

Orem

PROVO

Springville

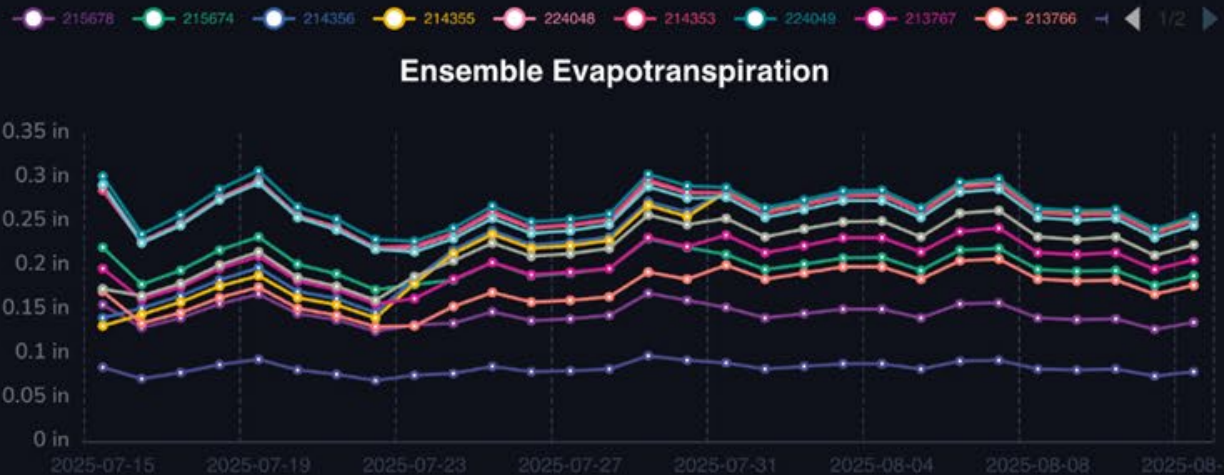
Spanish Fork

Duchesne

<https://farms.etdata.org>



Demo Report



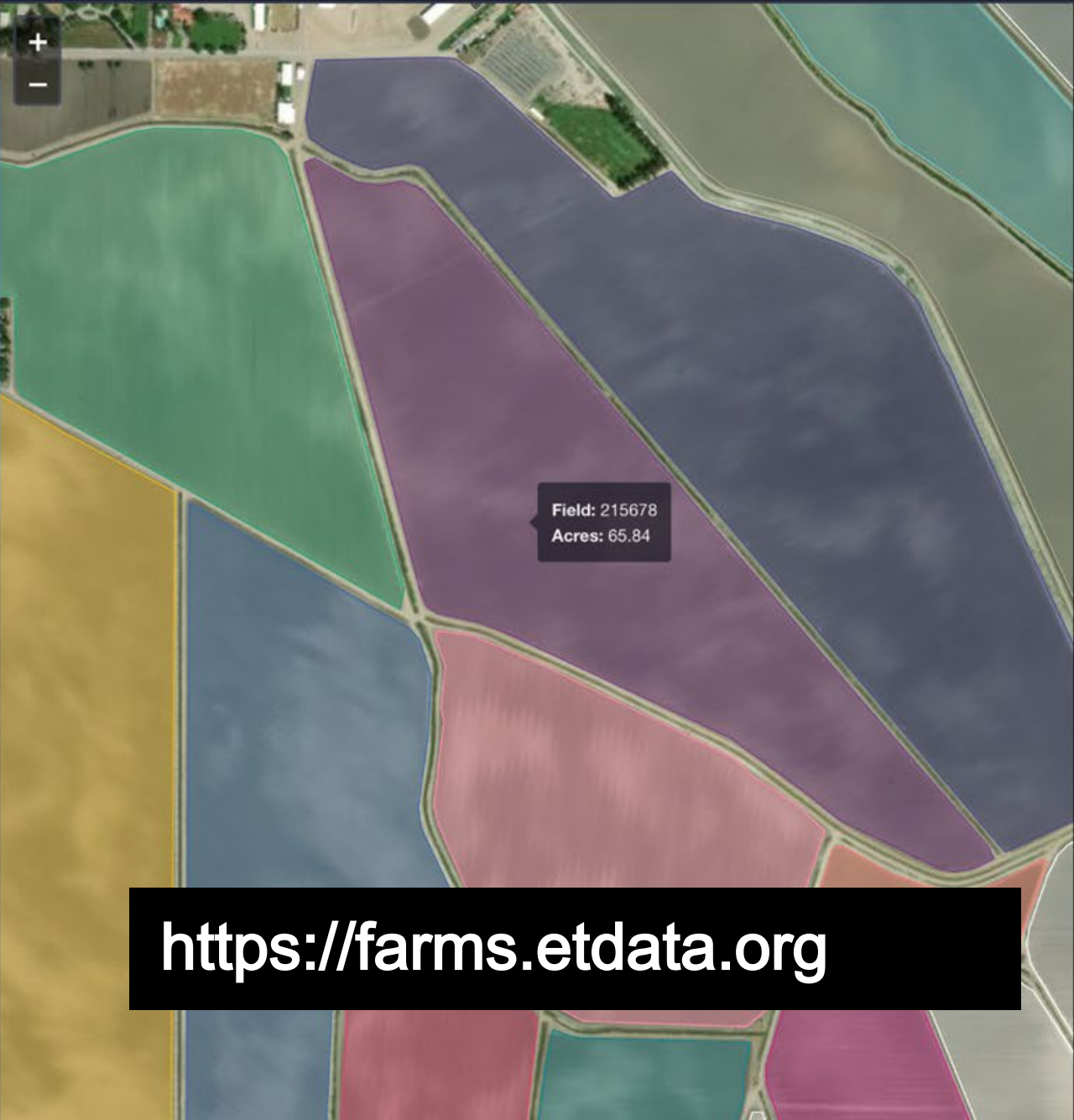
Report Data

Field ID: 215793
Acres: 46.48



MODEL: ensemble VARIABLE: et Field ID: 215793

Date	Value (inches)	Acre-Feet
2025-08-12	0.245	0.949
2025-08-11	0.231	0.895
2025-08-10	0.253	0.98
2025-08-09	0.251	0.972



<https://farms.etdata.org>