Remote sensing for multi-scale monitoring of agricultural water use

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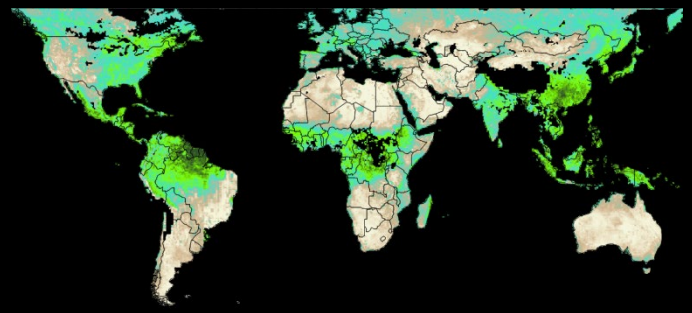
EVAPOTRANSPIRATION (ET)

evaporation + plant transpiration

- Irrigation management
- Monitoring drought and crop stress
- Yield prediction
- Water use accounting
- Crop water productivity (crop per drop)

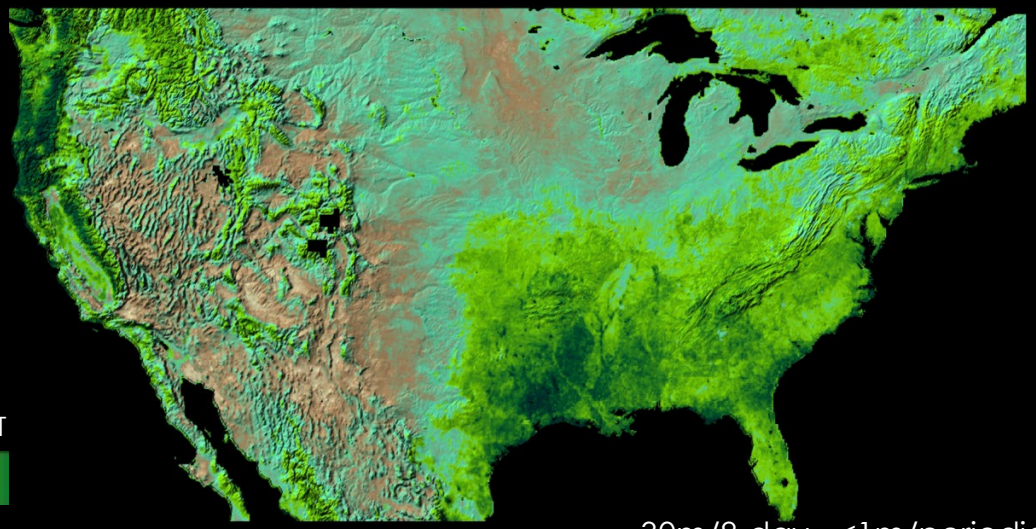
We can't manage
what we can't measure ...

Multi-Sensor/Multi-Scale ET Mapping

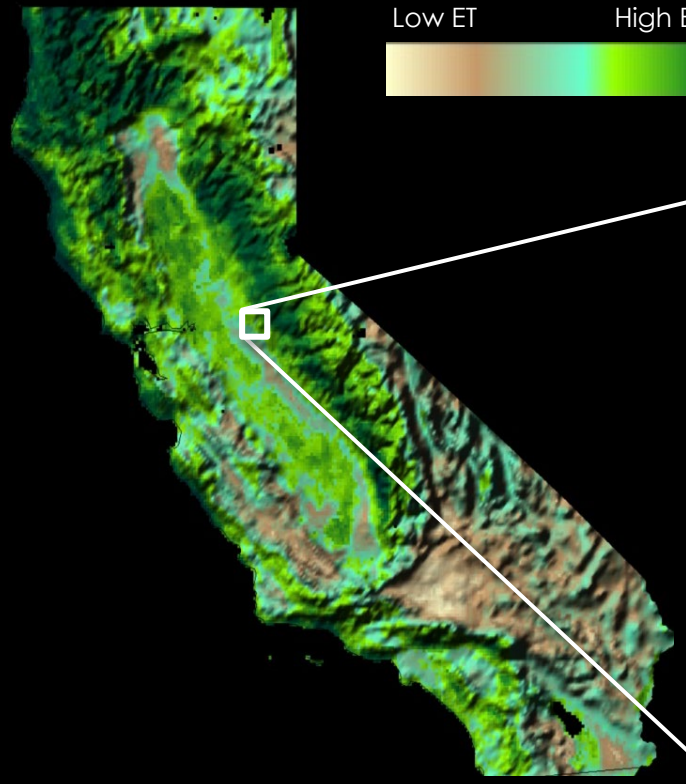


International geostationary constellation
3-5km, 15-min

NOAA Geostationary Operational Environmental Satellites

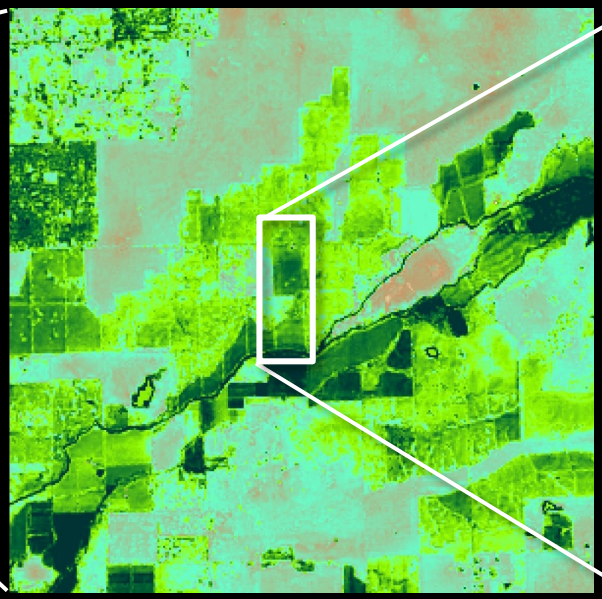


MODIS 1km,daily

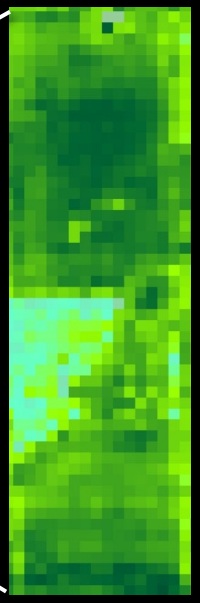


Low ET High ET

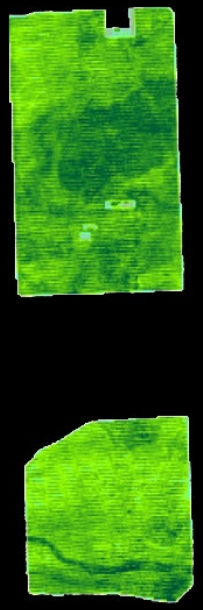
Multi-sensor fusion (daily/30 m)

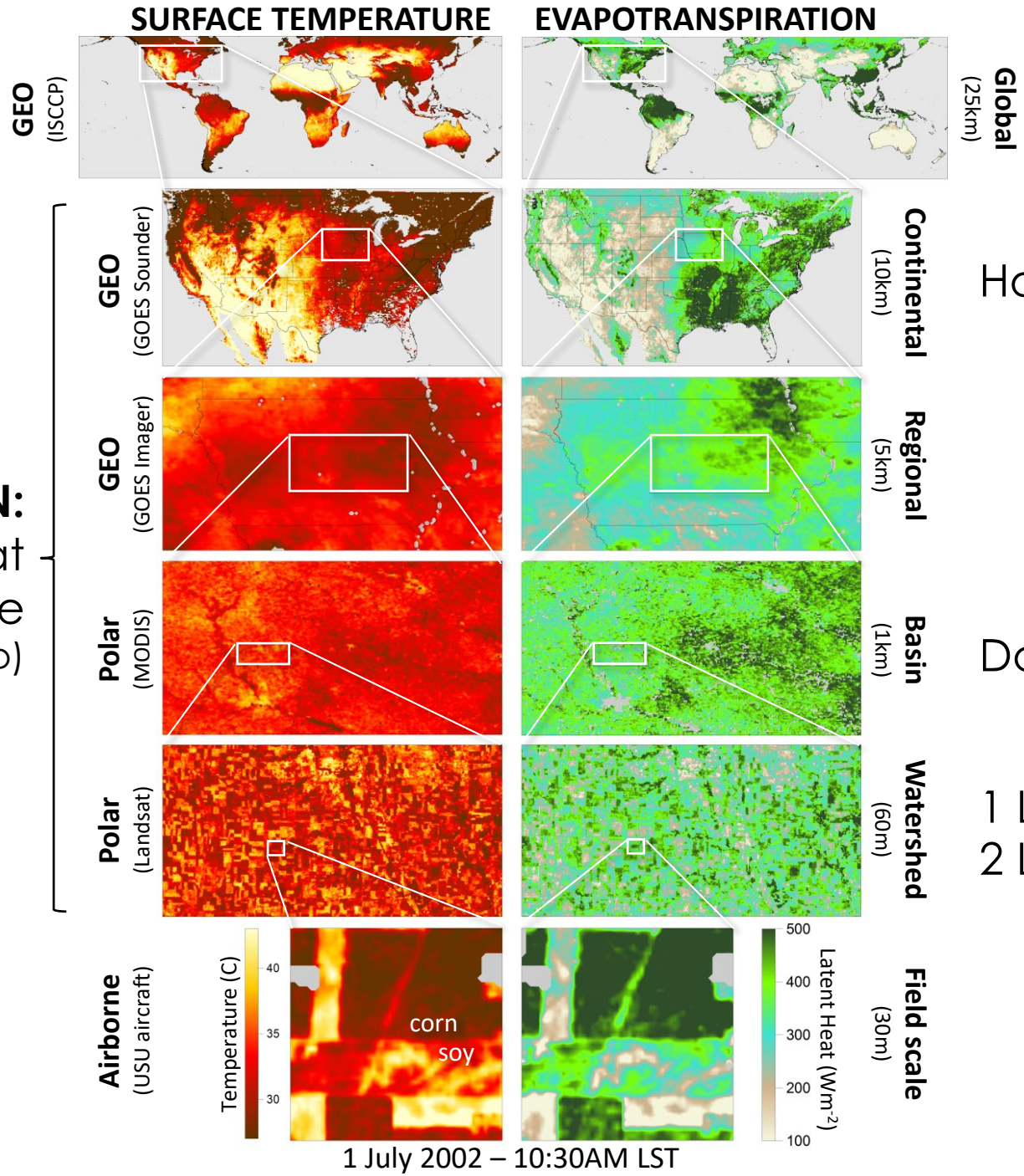


30m/8-day
Landsat



<1m/periodic
UAV/Aircraft



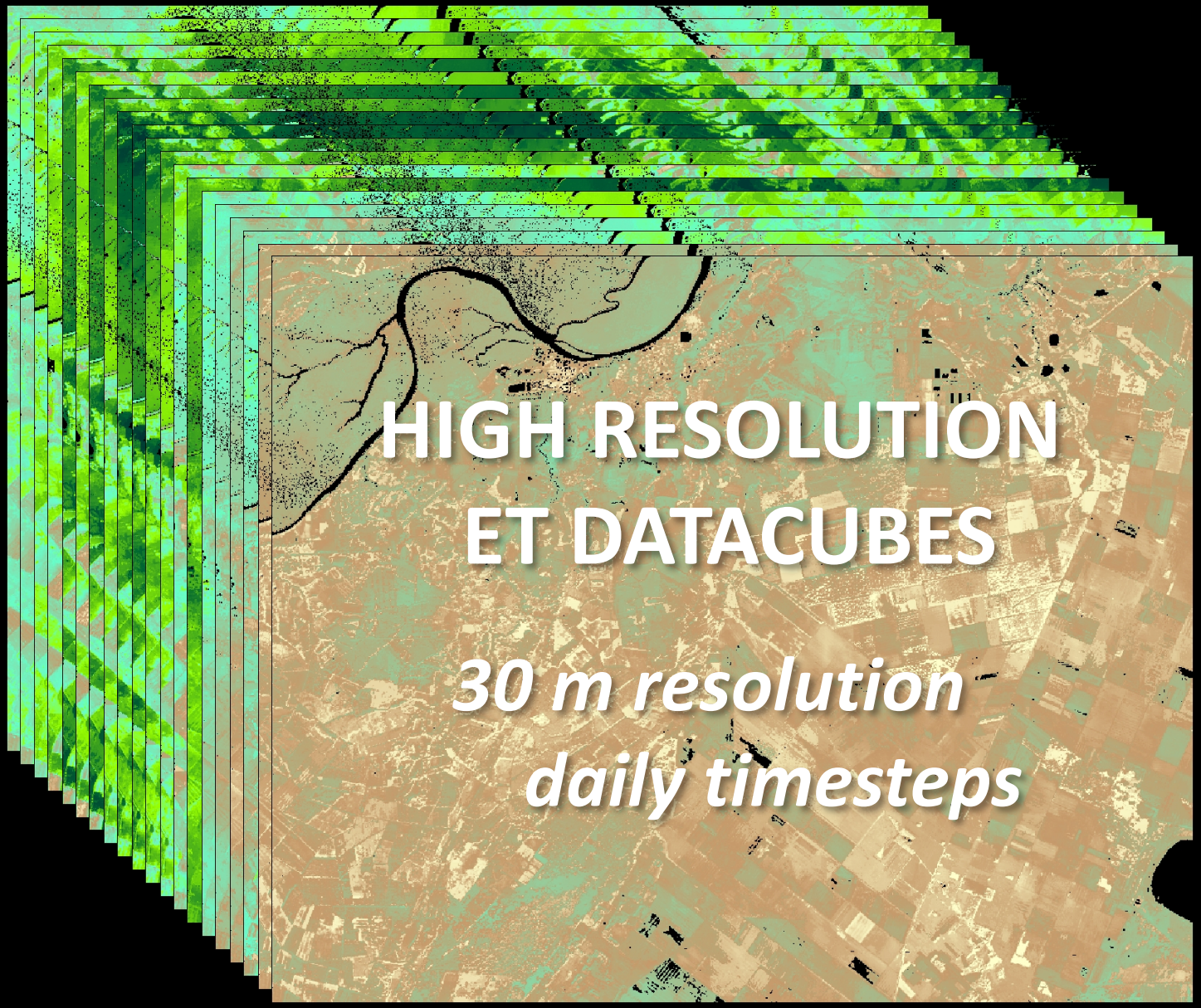


DATA FUSION:
daily ET at field scale
(F. Gao)

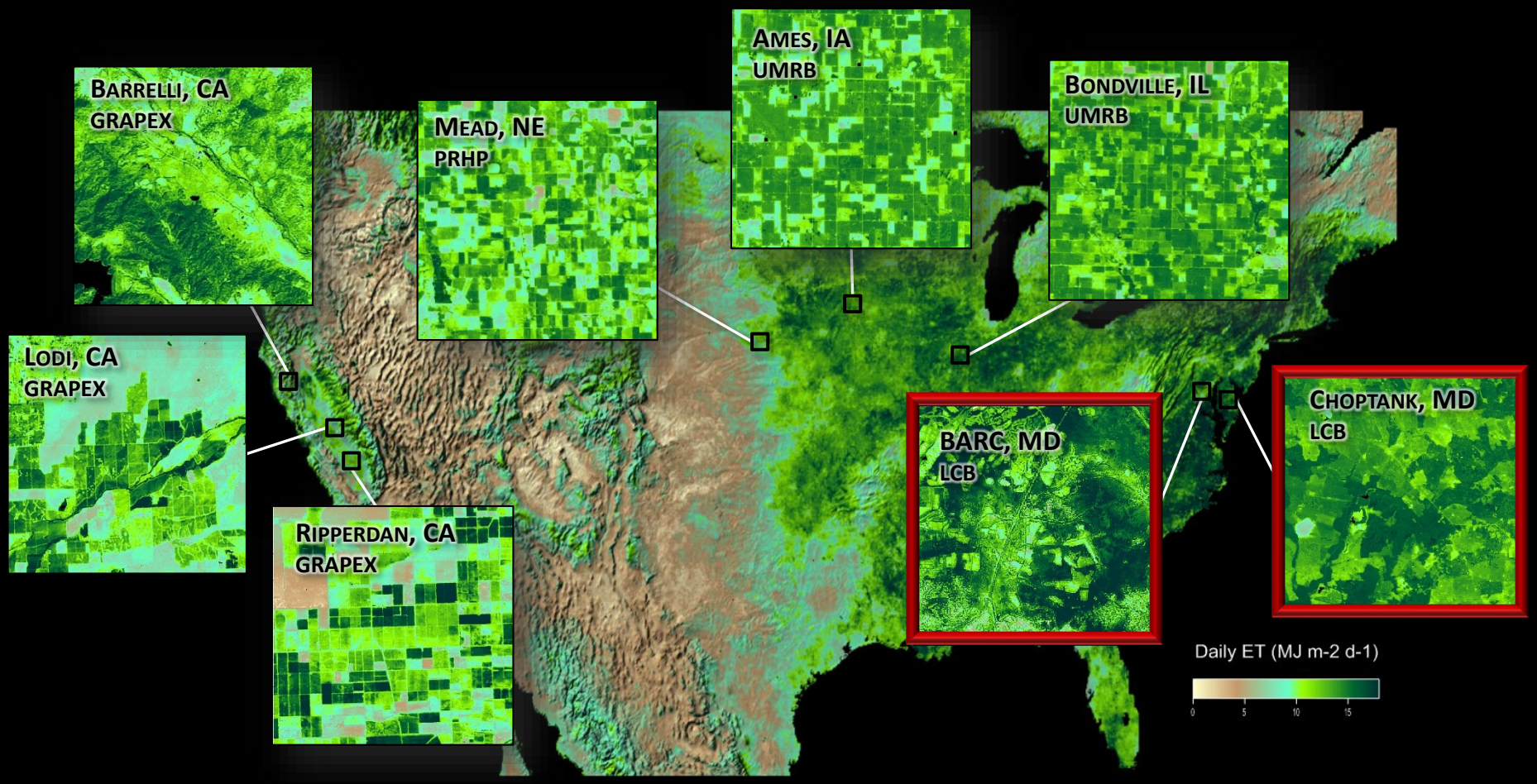
Hourly

Daily

1 LS – 16 day
2 LS – 8 day


HIGH RESOLUTION
ET DATACUBES
30 m resolution
daily timesteps

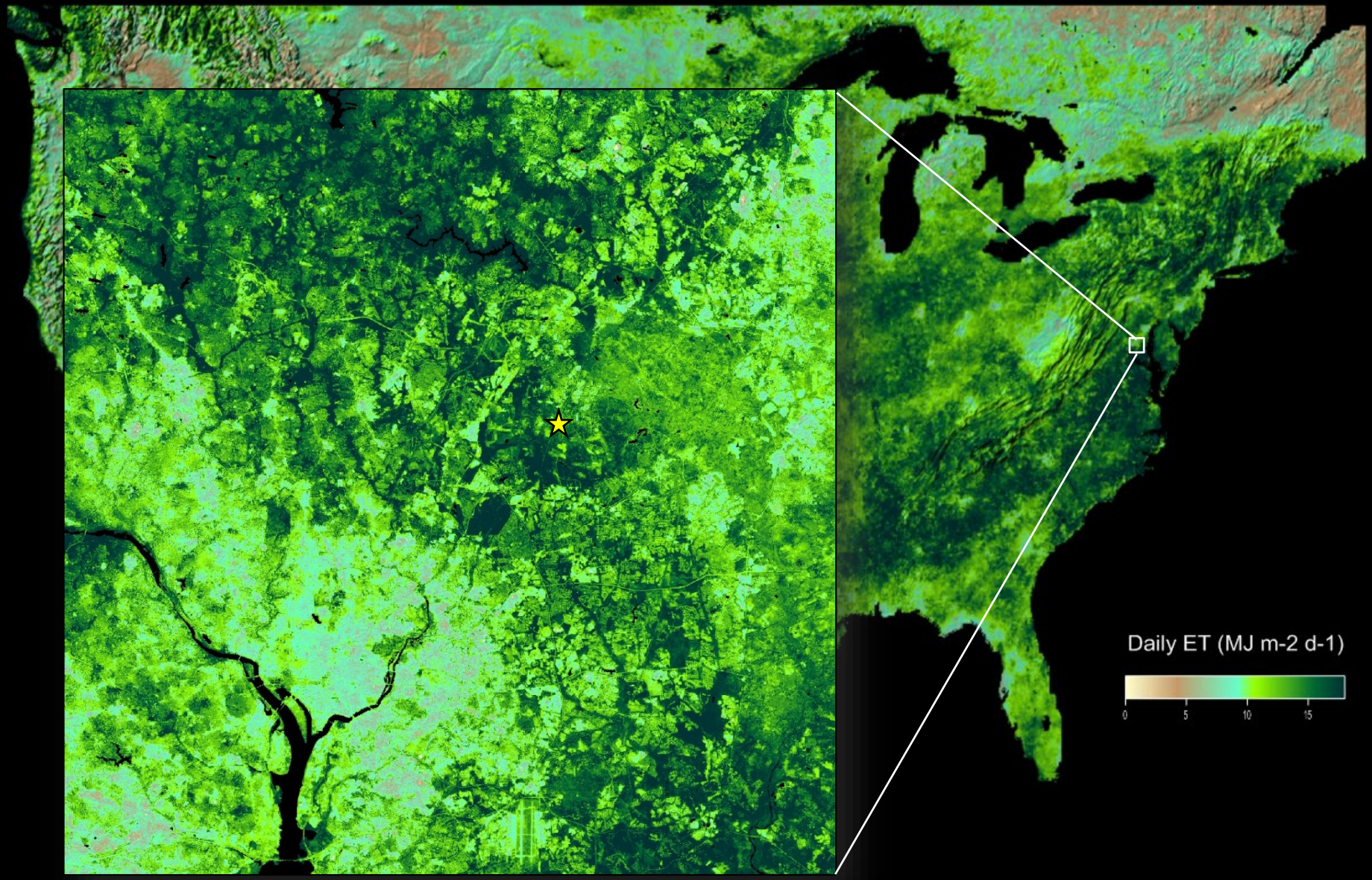
U.S. ET Datacube Development Sites



USDA-ARS Long-Term Agroecosystem Research (LTAR) Sites

PRHP	Platte River-High Plains	LCB	Lower Chesapeake Bay
UMRB	Upper Mississippi River Basin	CA	Proposed site

Lower Chesapeake Bay LTAR Sites



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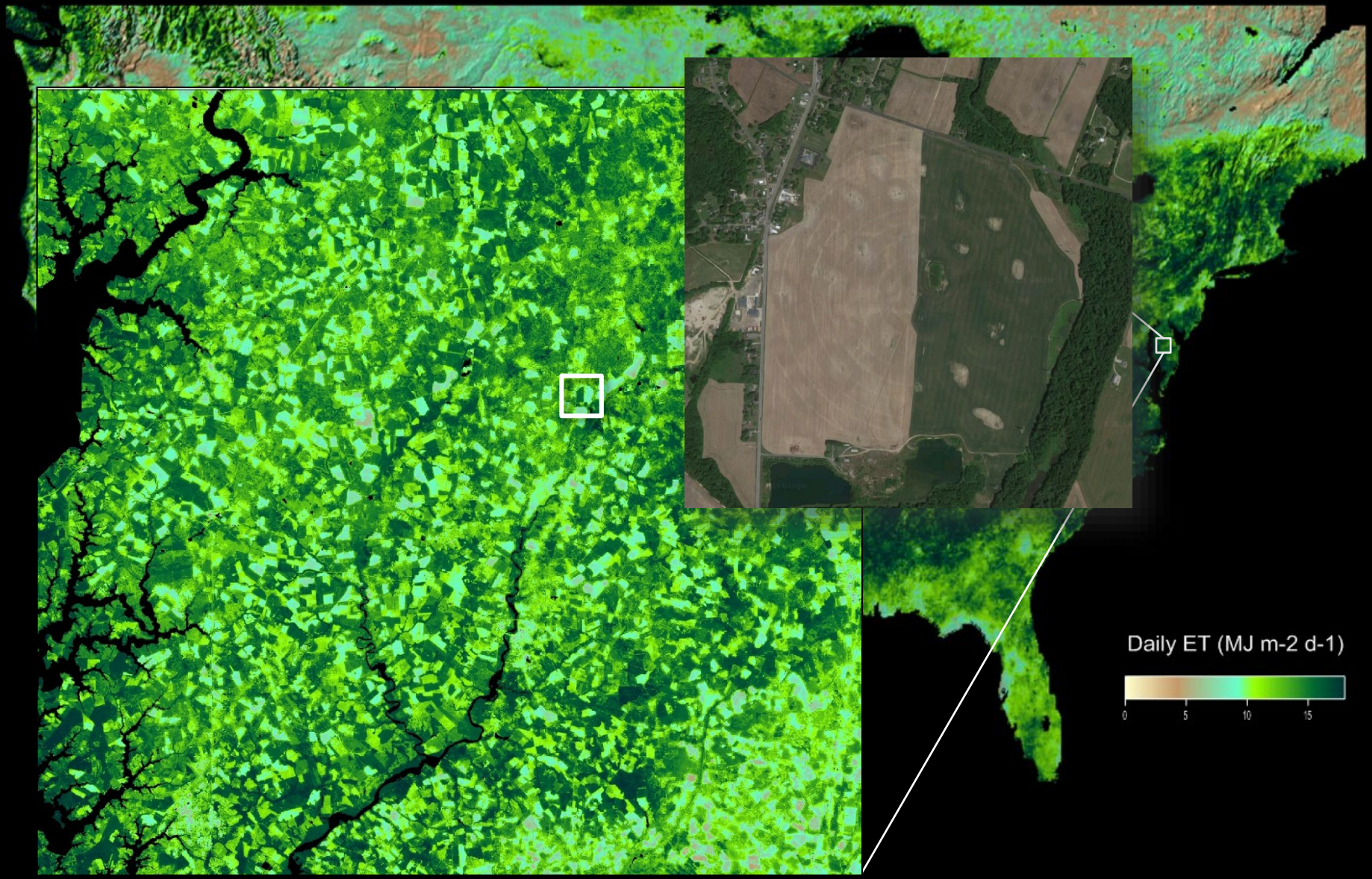
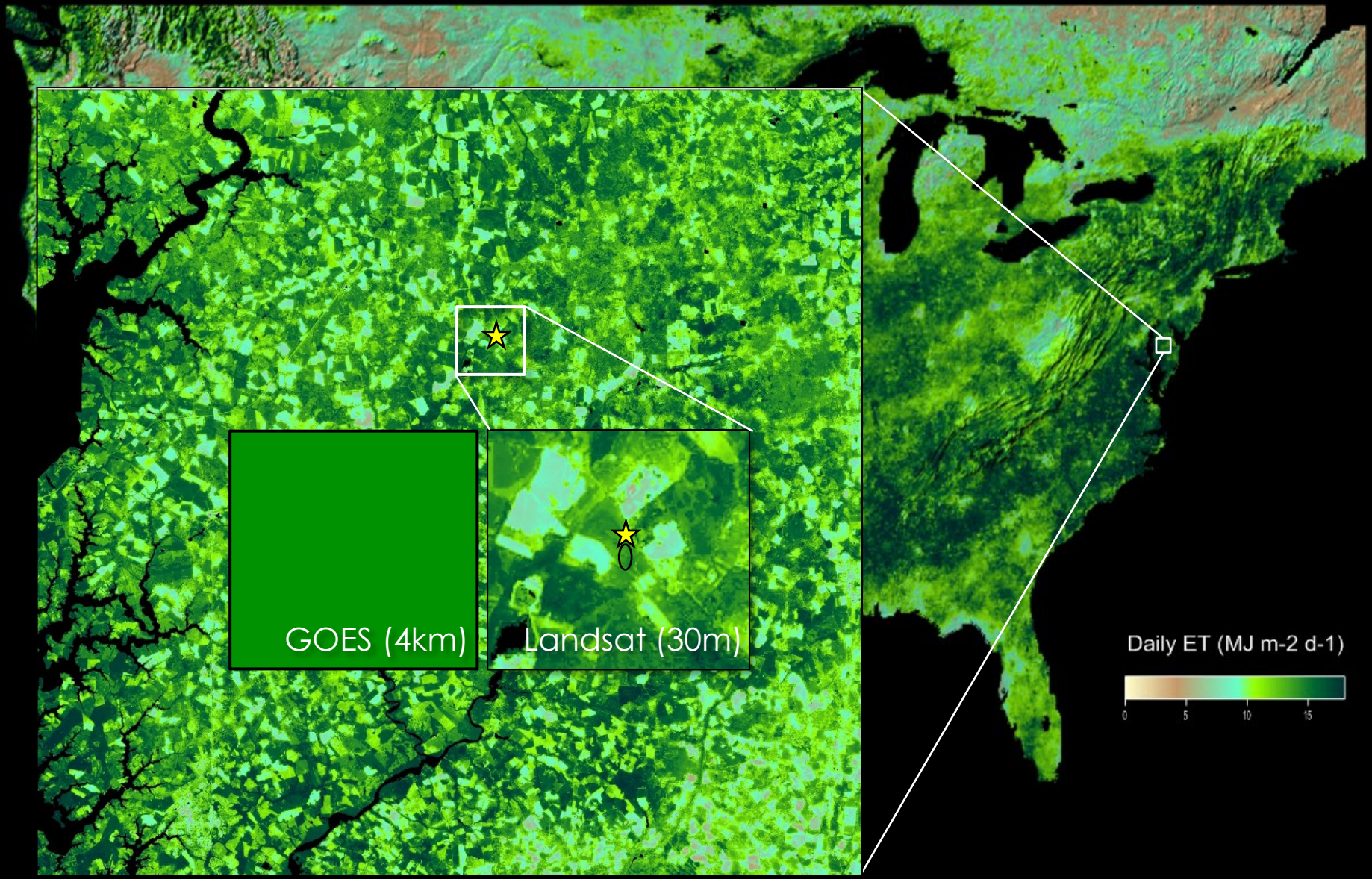
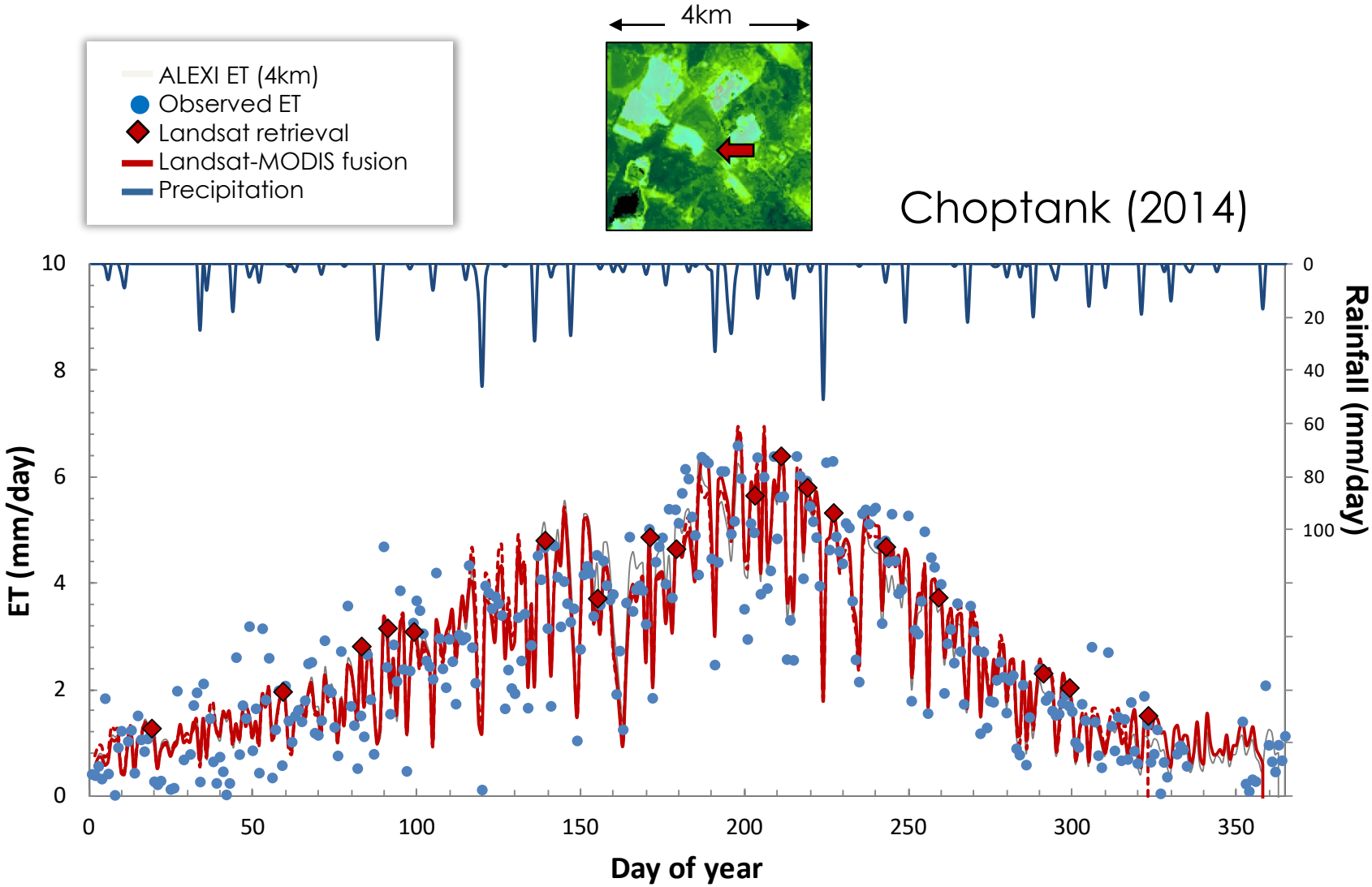


Lower Chesapeake Bay LTAR Sites

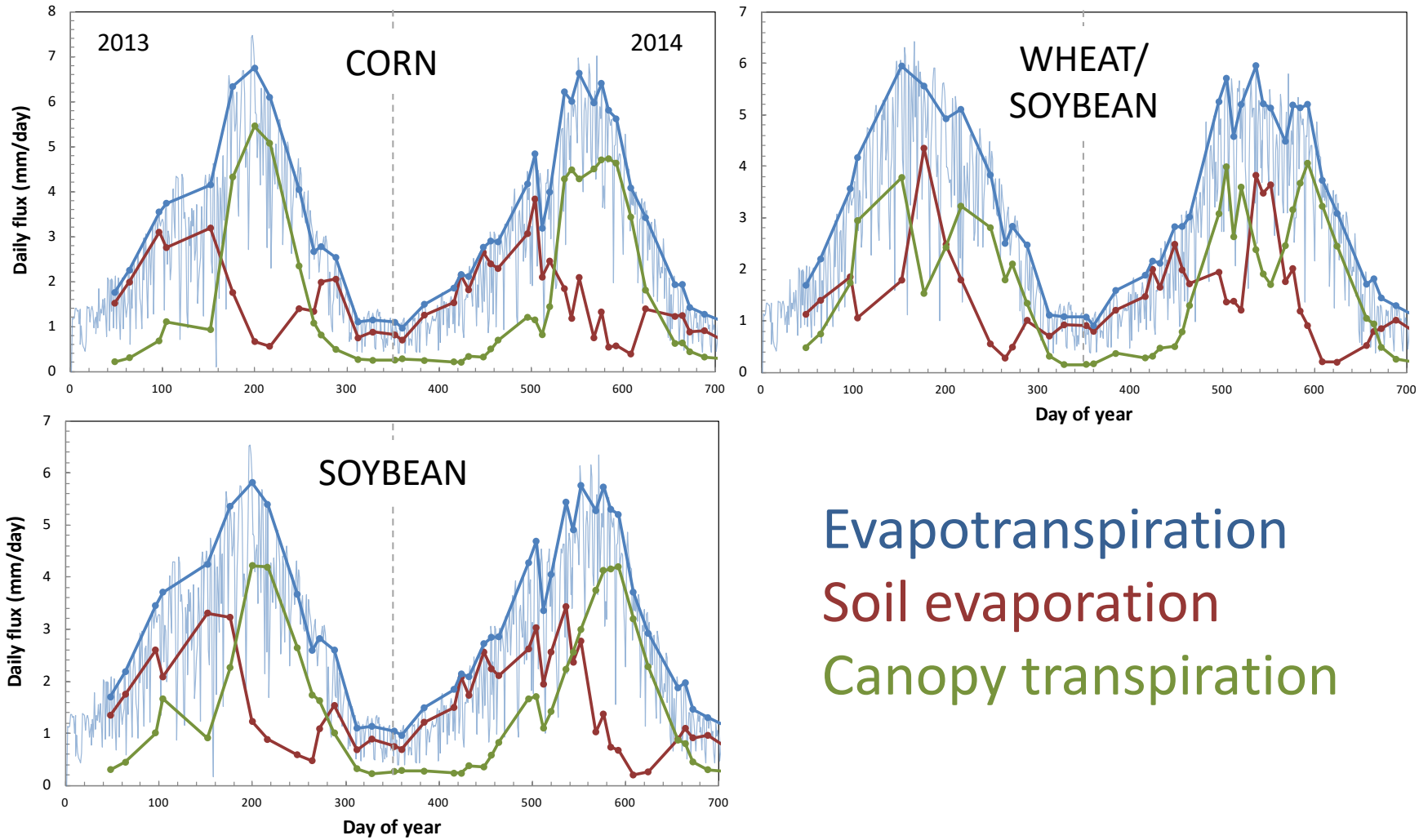


Comparisons with flux tower data



Sun, L. et al. (2016). Monitoring daily evapotranspiration at field-scale over an agricultural landscape on the Eastern Shore of Maryland. *Remote Sens. Environ., in preparation*

T/E SEPARATION ON CLEAR LANDSAT DATES

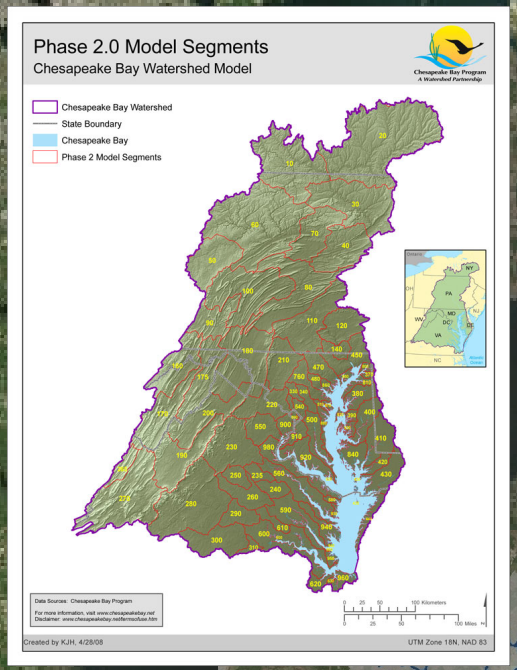


Evapotranspiration

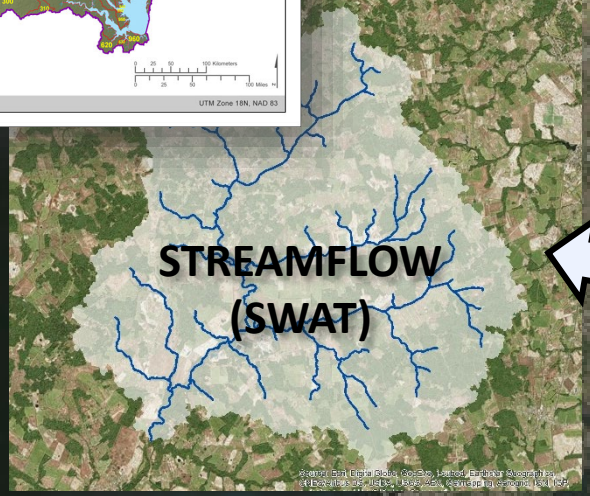
Soil evaporation

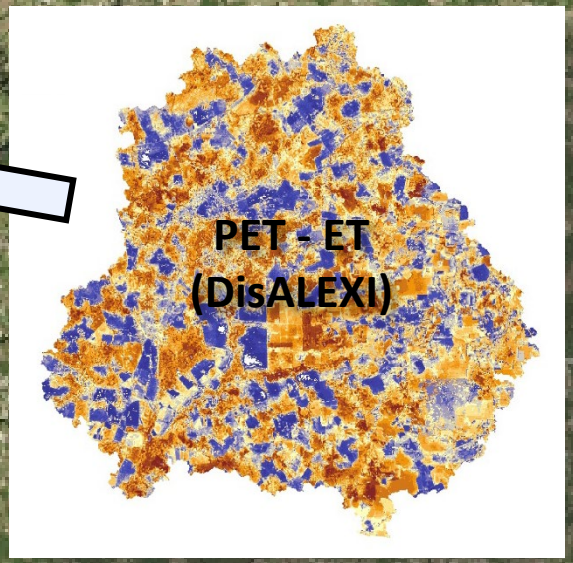
Canopy transpiration

Calibrating watershed model with ET



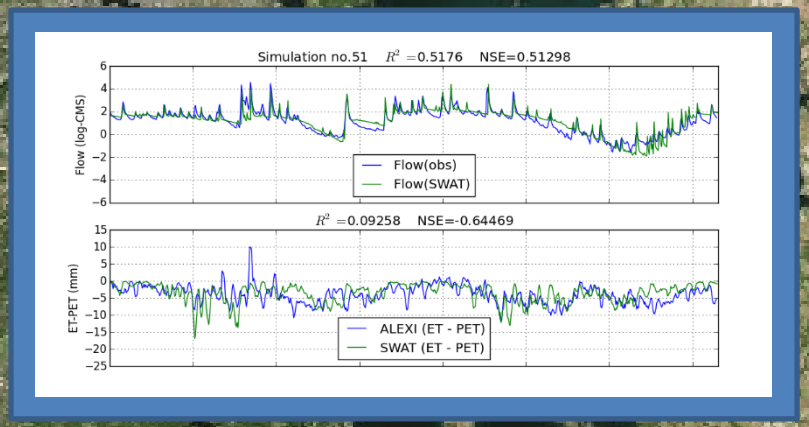
Greensboro basin

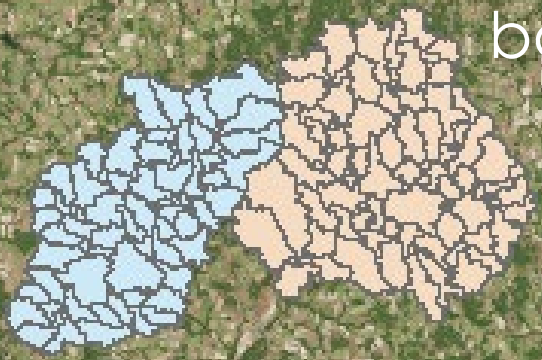


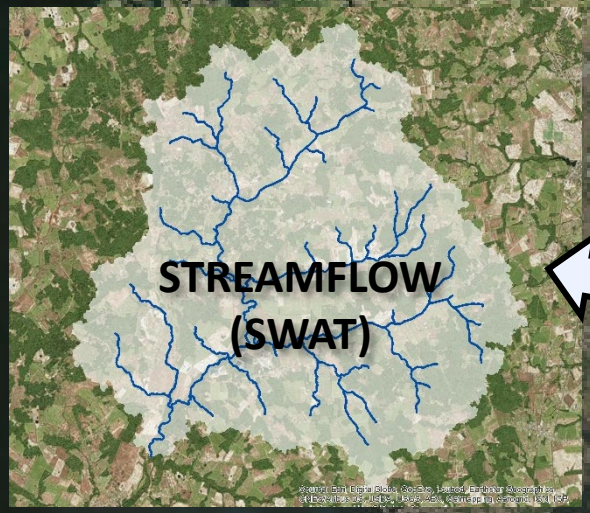


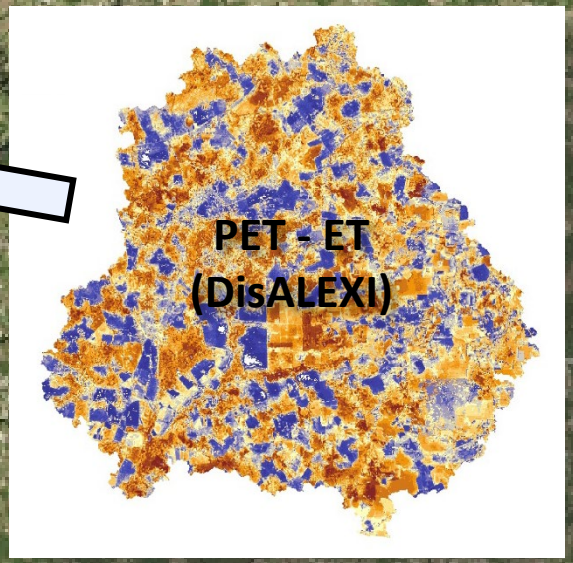
Strategy: Iteratively calibrate Soil Water Assessment Tool (SWAT) parameters using PET-ET from remote sensing aggregated to sub-basins. (Sharifi et al., 2017)

Calibrating watershed model with ET









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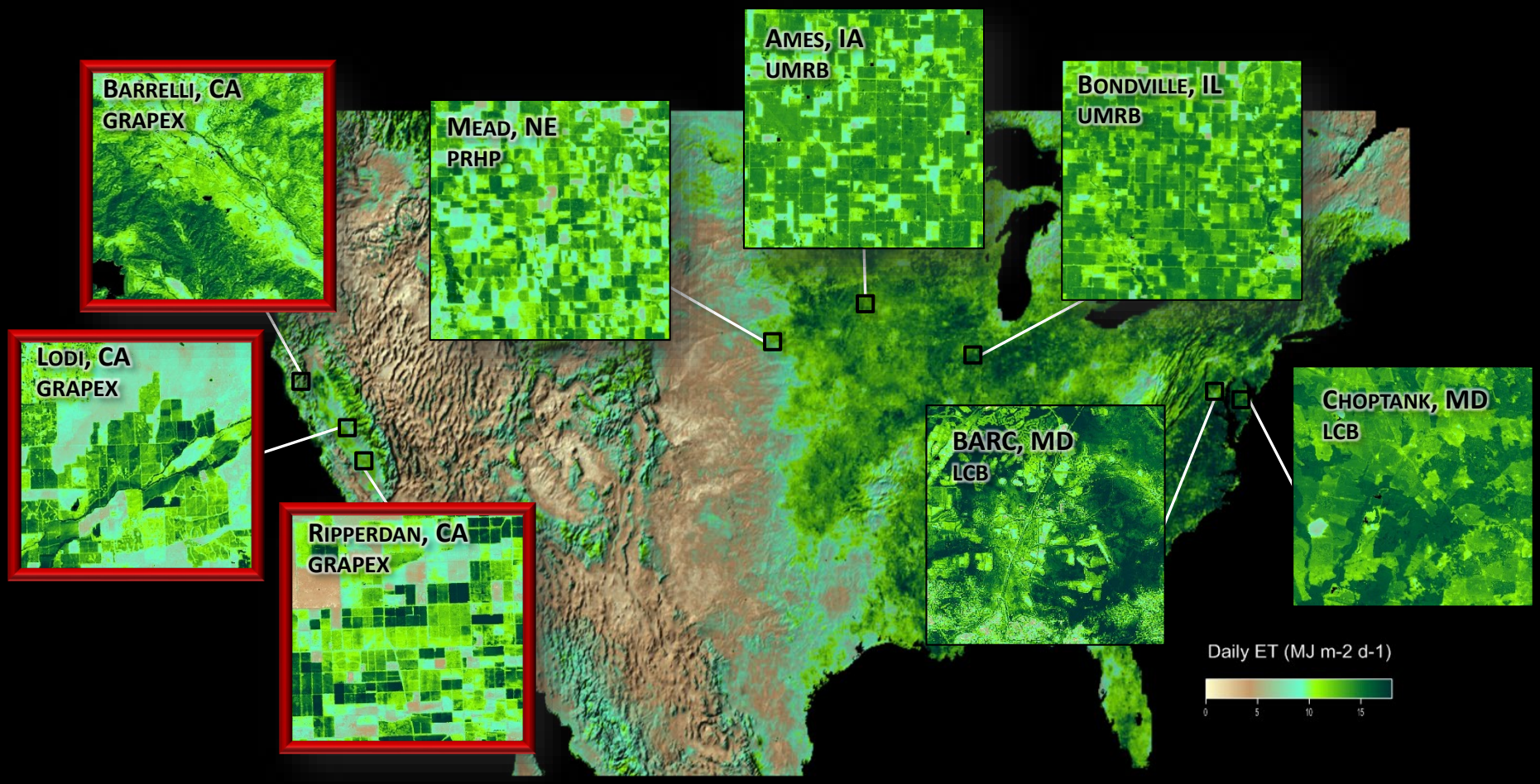
U.S. ET Datacube Development Sites



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GRAPEX

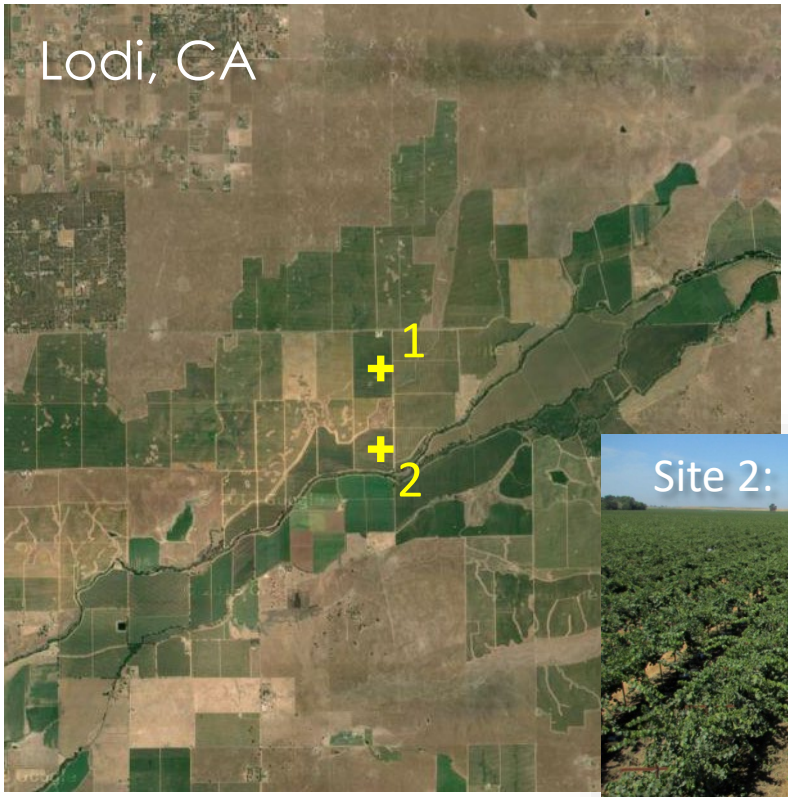
Grape Remote sensing Atmospheric Profile and Evapotranspiration eXperiment

E&J Gallo Winery

Develop remote sensing based irrigation management strategy that uses less water while maintaining or improving grape yield and quality

GRAPEX

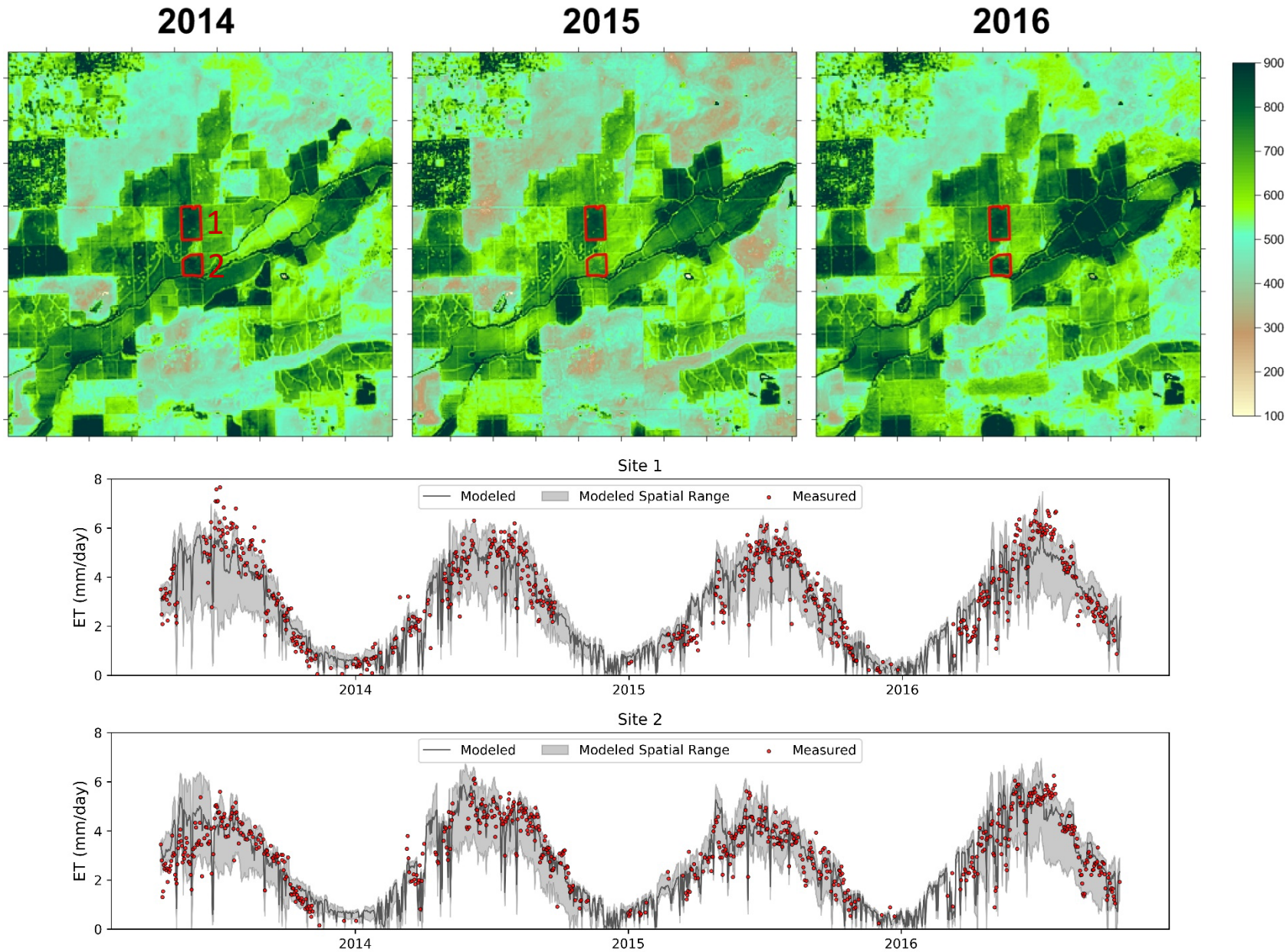
Grape Remote sensing Atmospheric Profile and Evapotranspiration eXperiment



2013-present

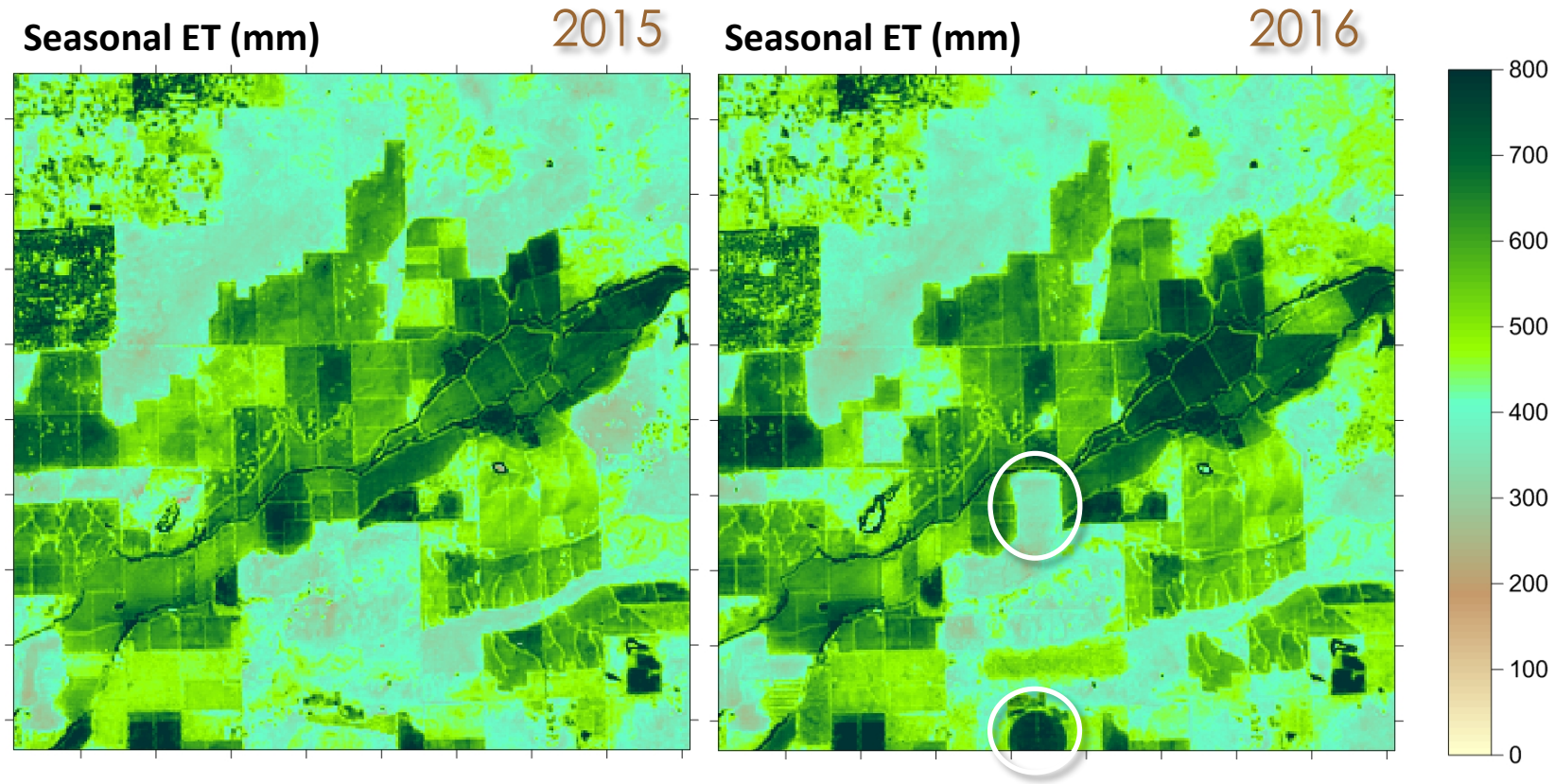
Sierra Loma vineyards

Measure of actual water use

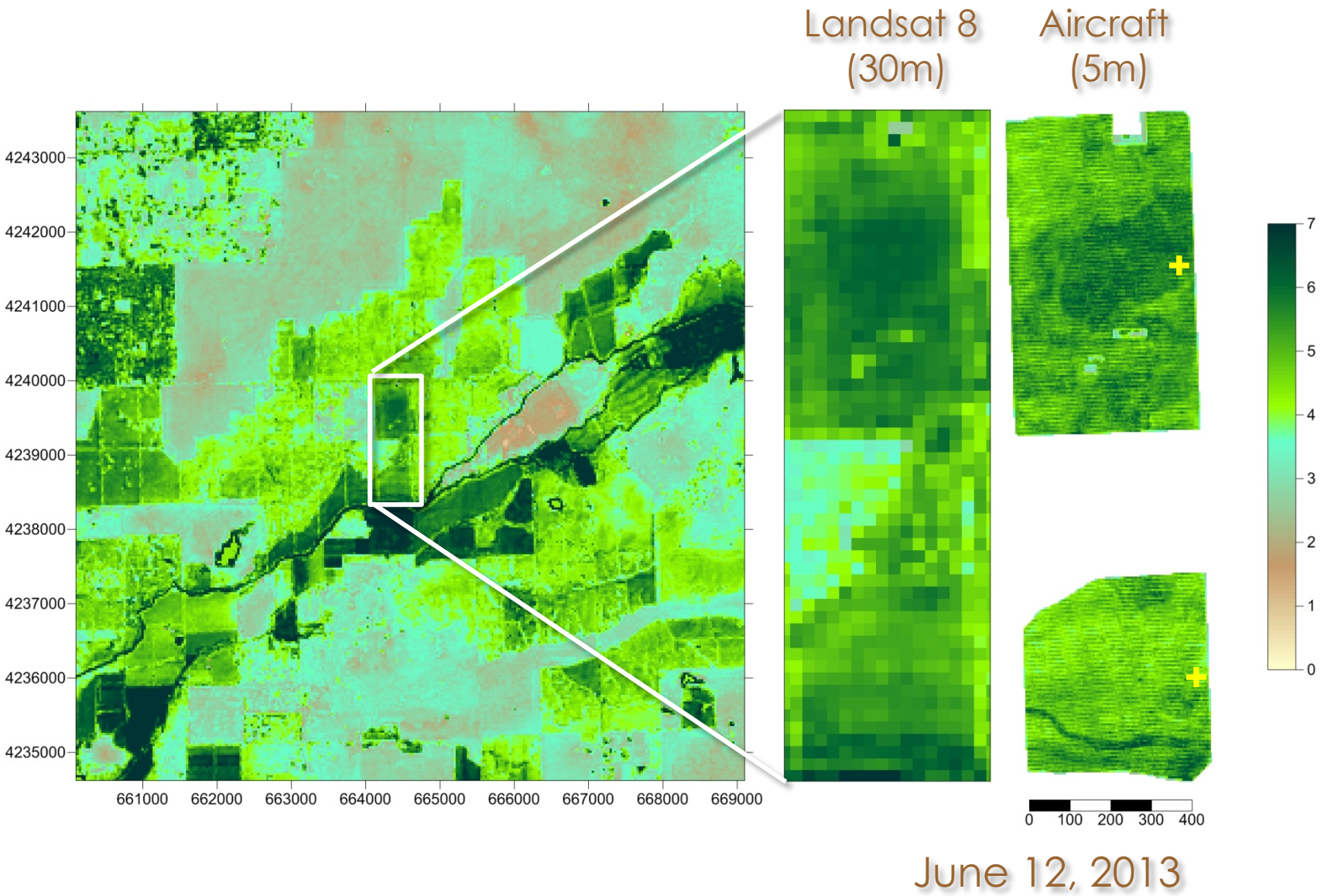


How does ET vary year-to-year?

GRAPEX, Lodi CA



How does ET vary within-field?



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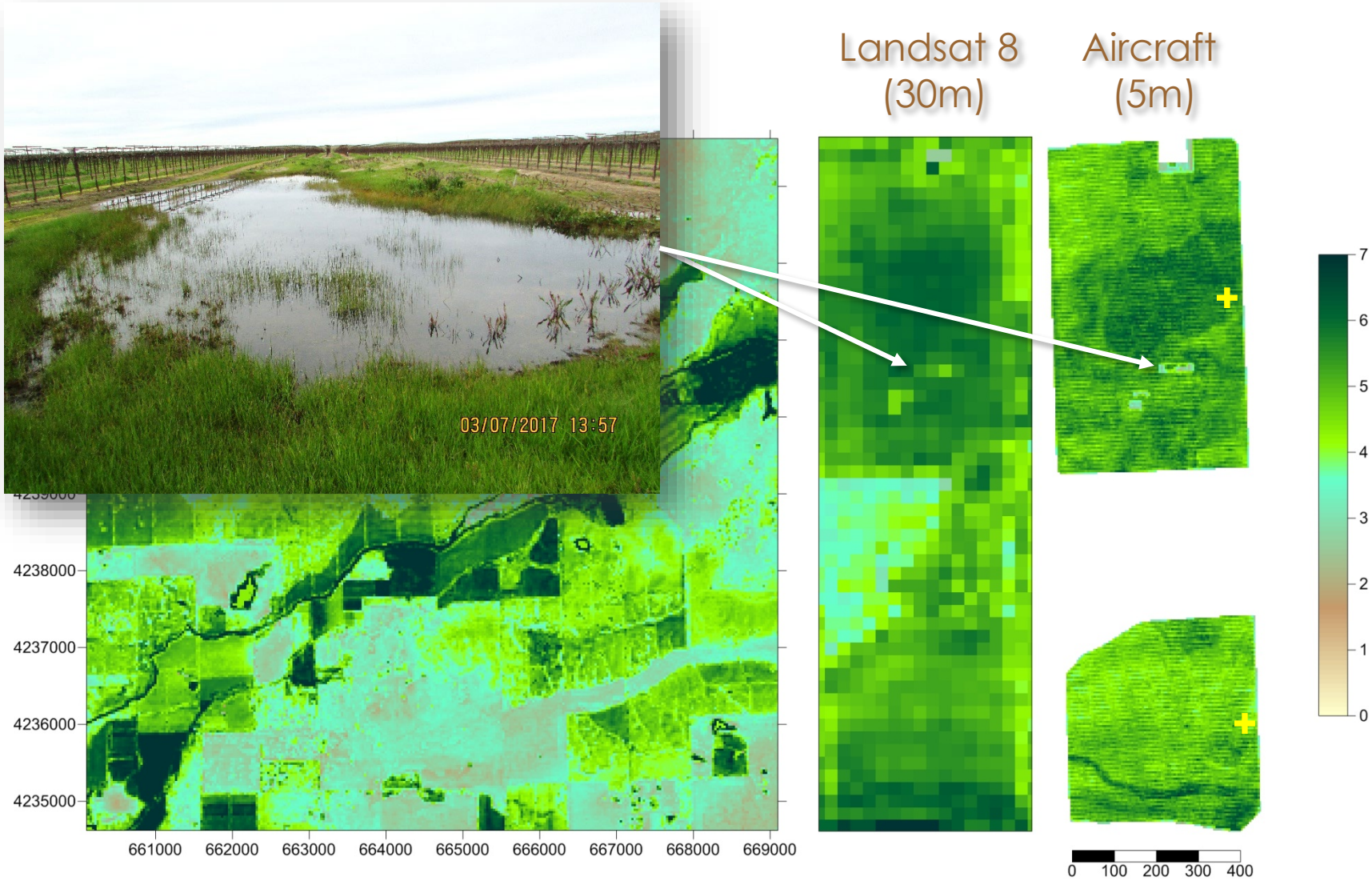
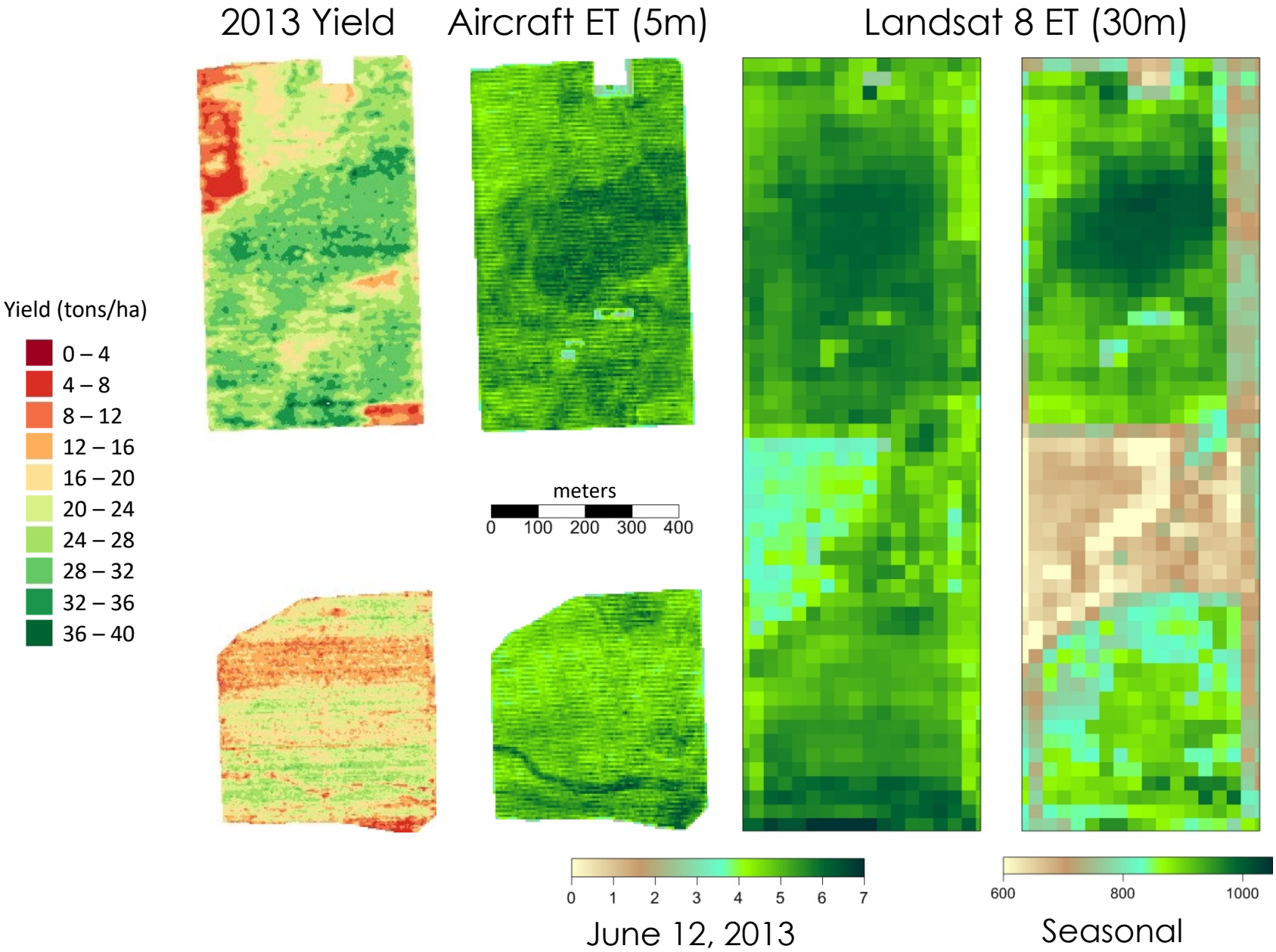


June 12, 2013

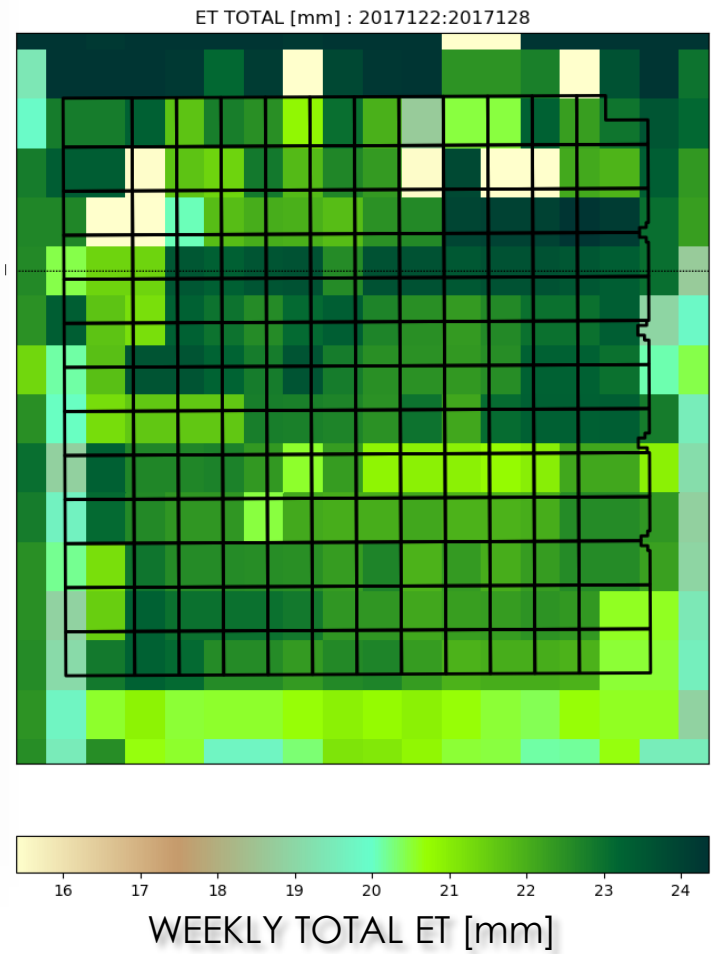
How does ET vary within-field?



Application: vineyard irrigation

VARIABLE RATE DRIP IRRIGATION (VRDI)

30x30m blocks with independent irrigation control



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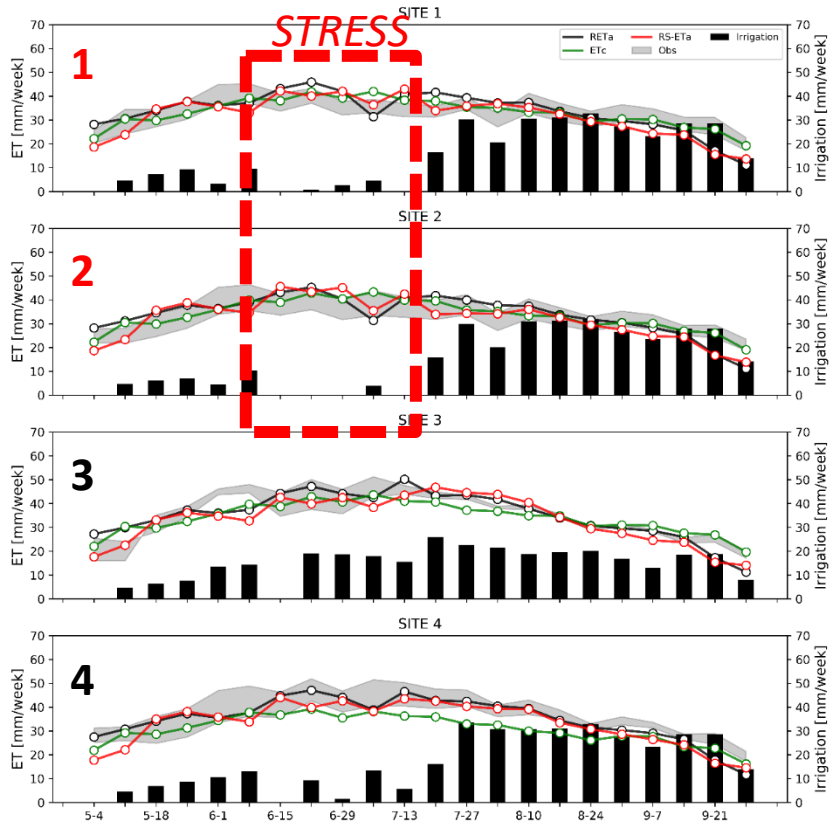

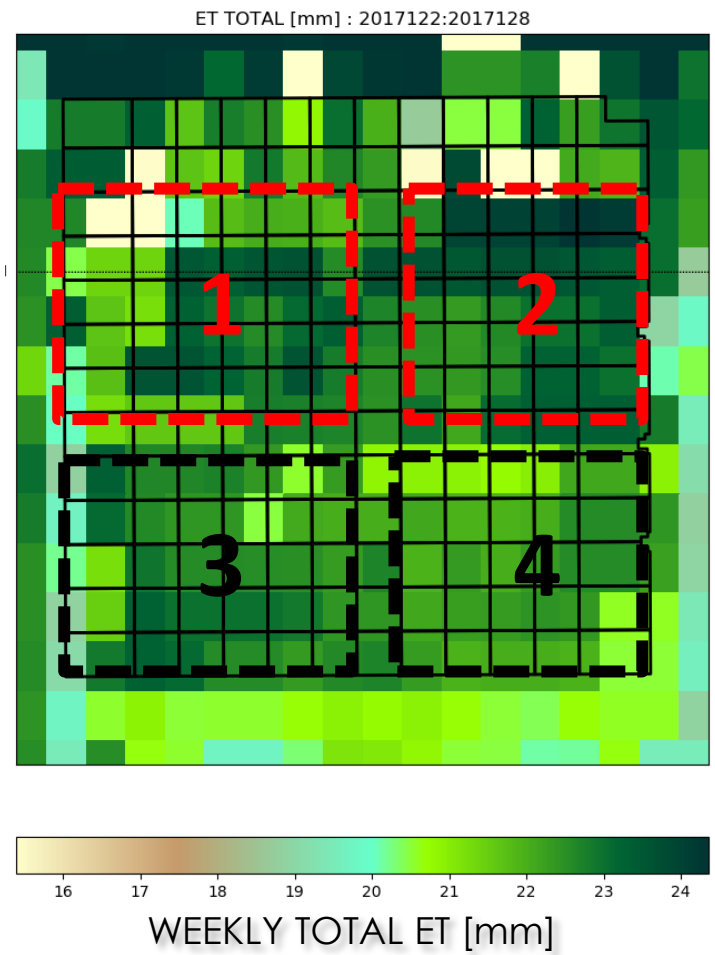

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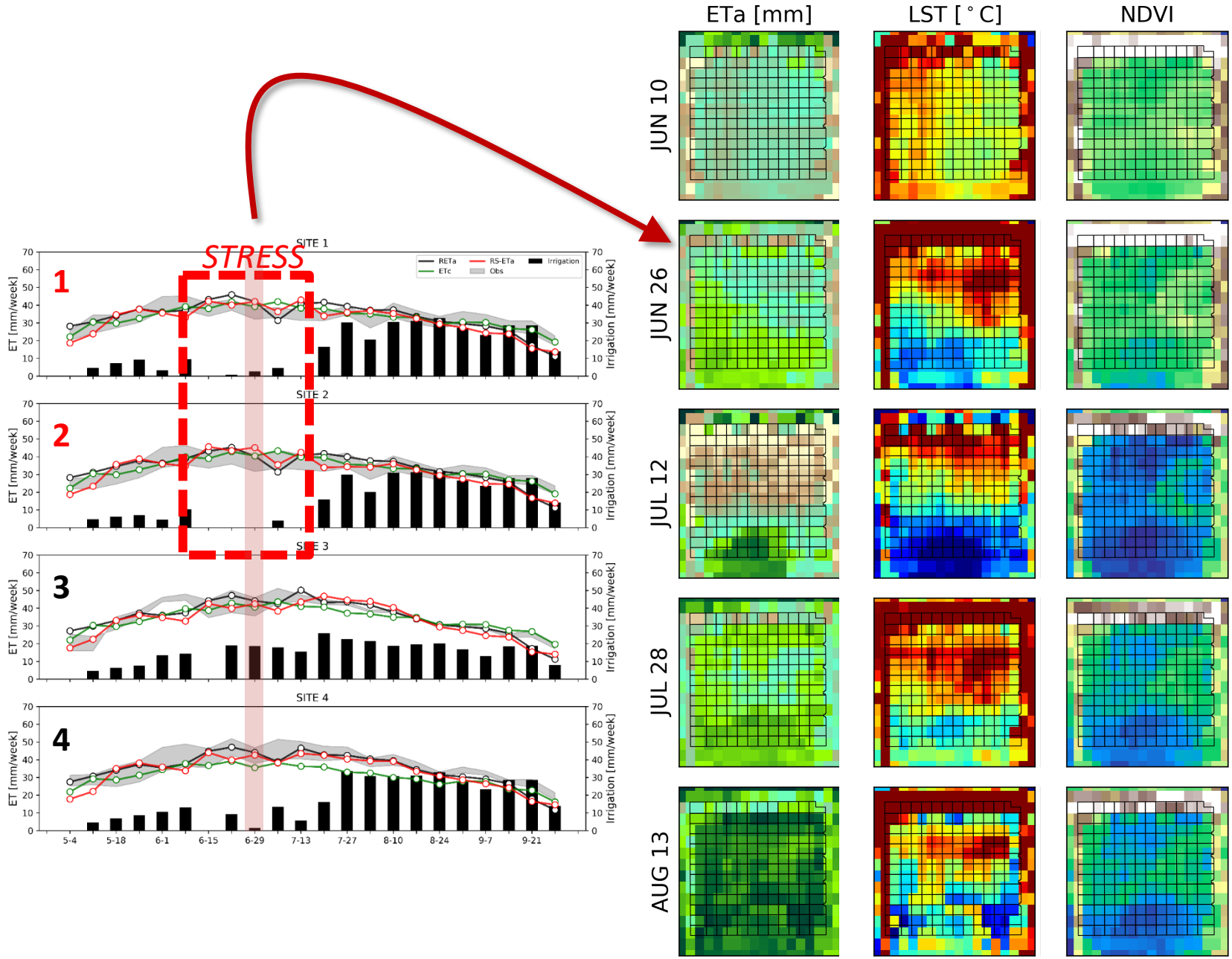
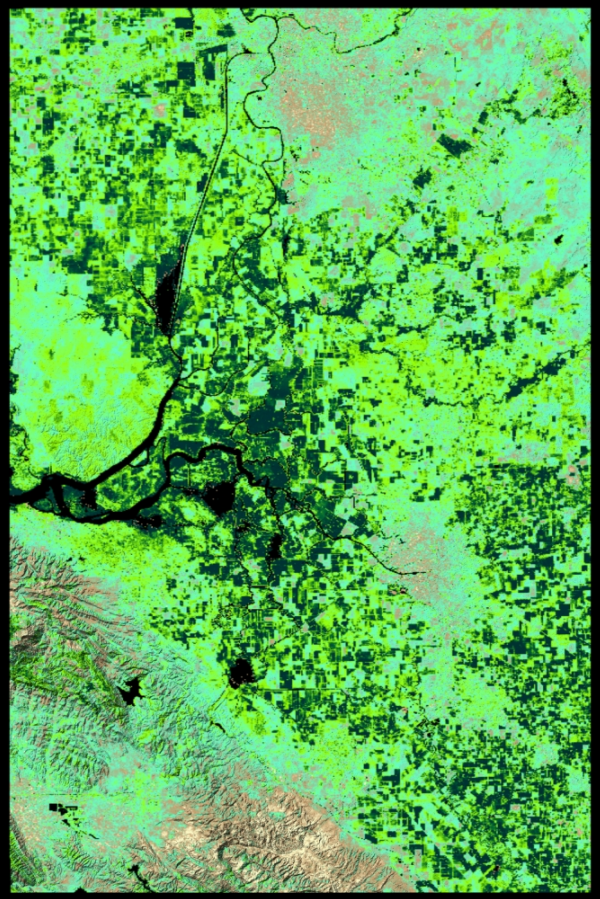
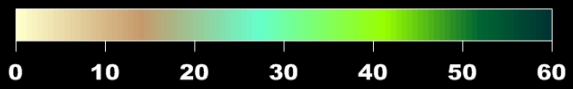


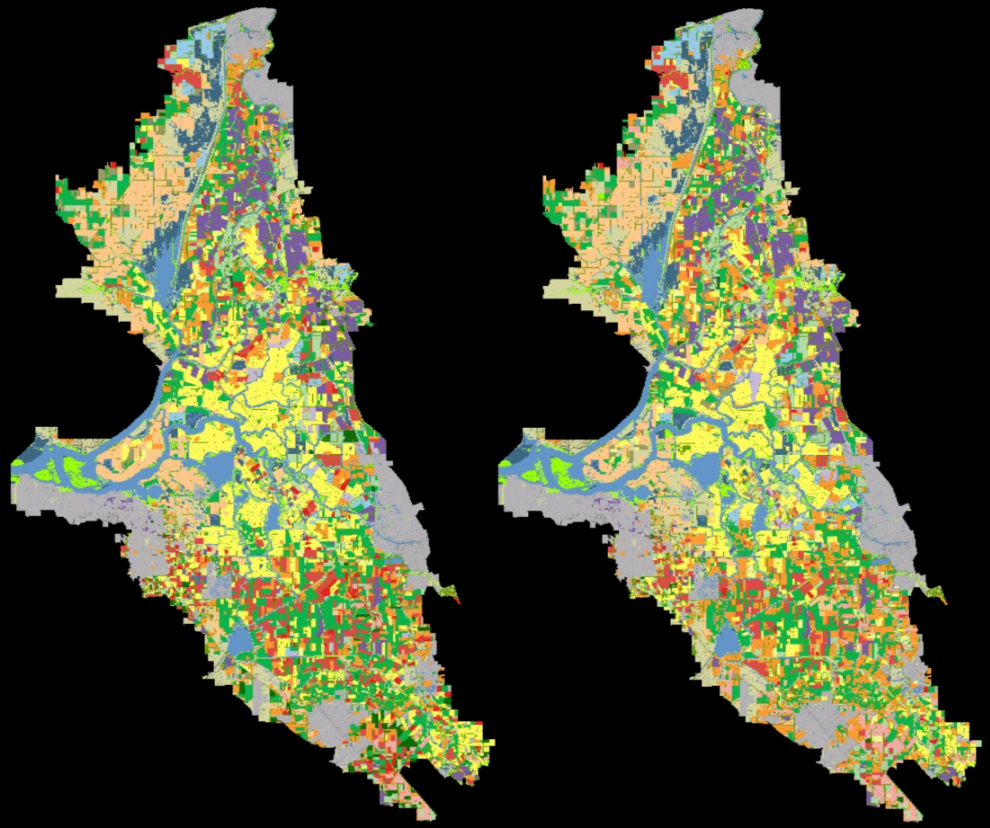
Sacramento – San Joaquin Delta Water Accounting

10day ET (mm) 2015200



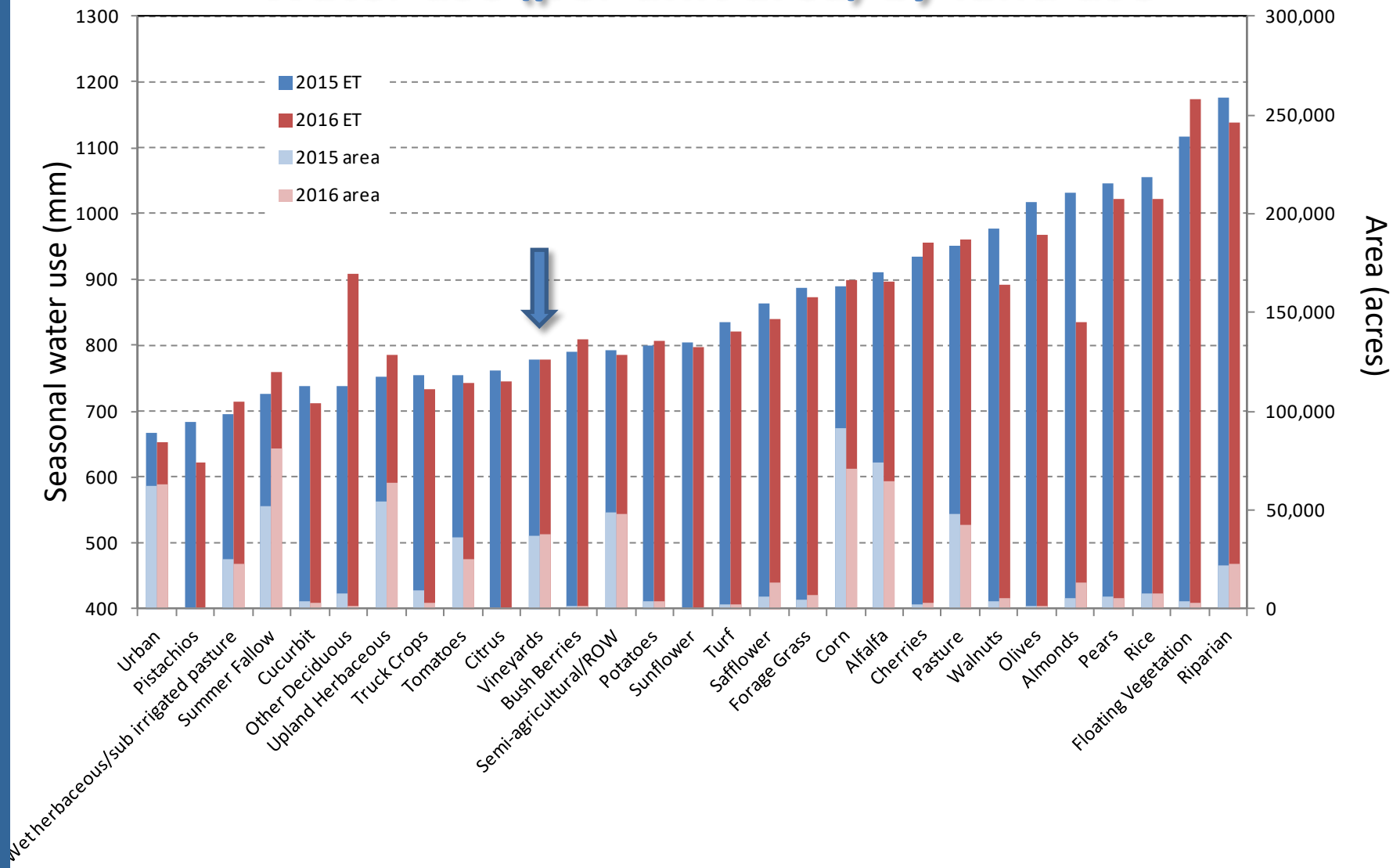


2015 **Landuse** 2016

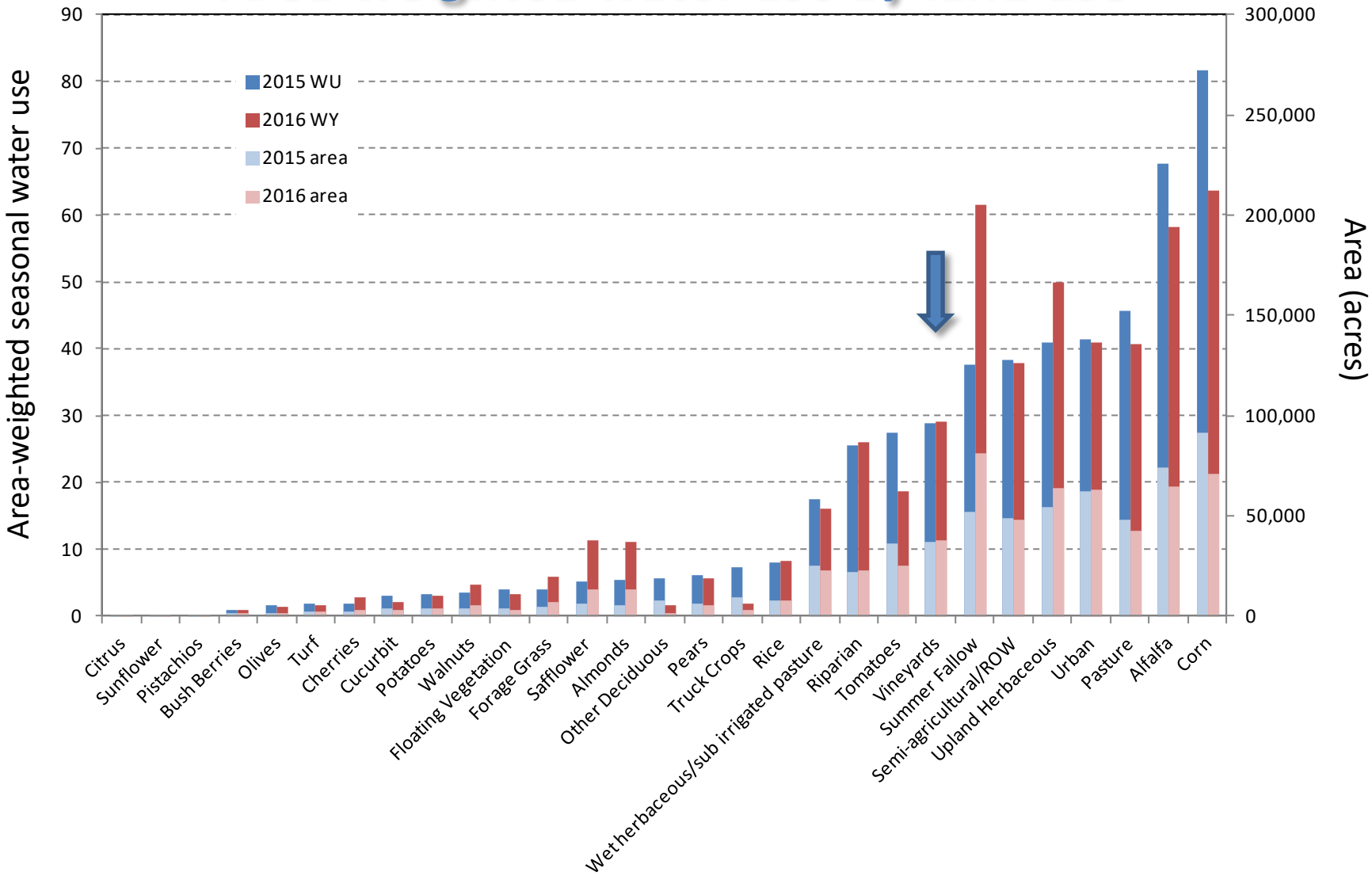


Corn	Rice	Tomatoes
Alfalfa	Summer fallow	Vineyards
Wetland	Forage grass	Urban
Pasture	Riparian	Almonds
Upland herb.	Water	Semi-ag/row

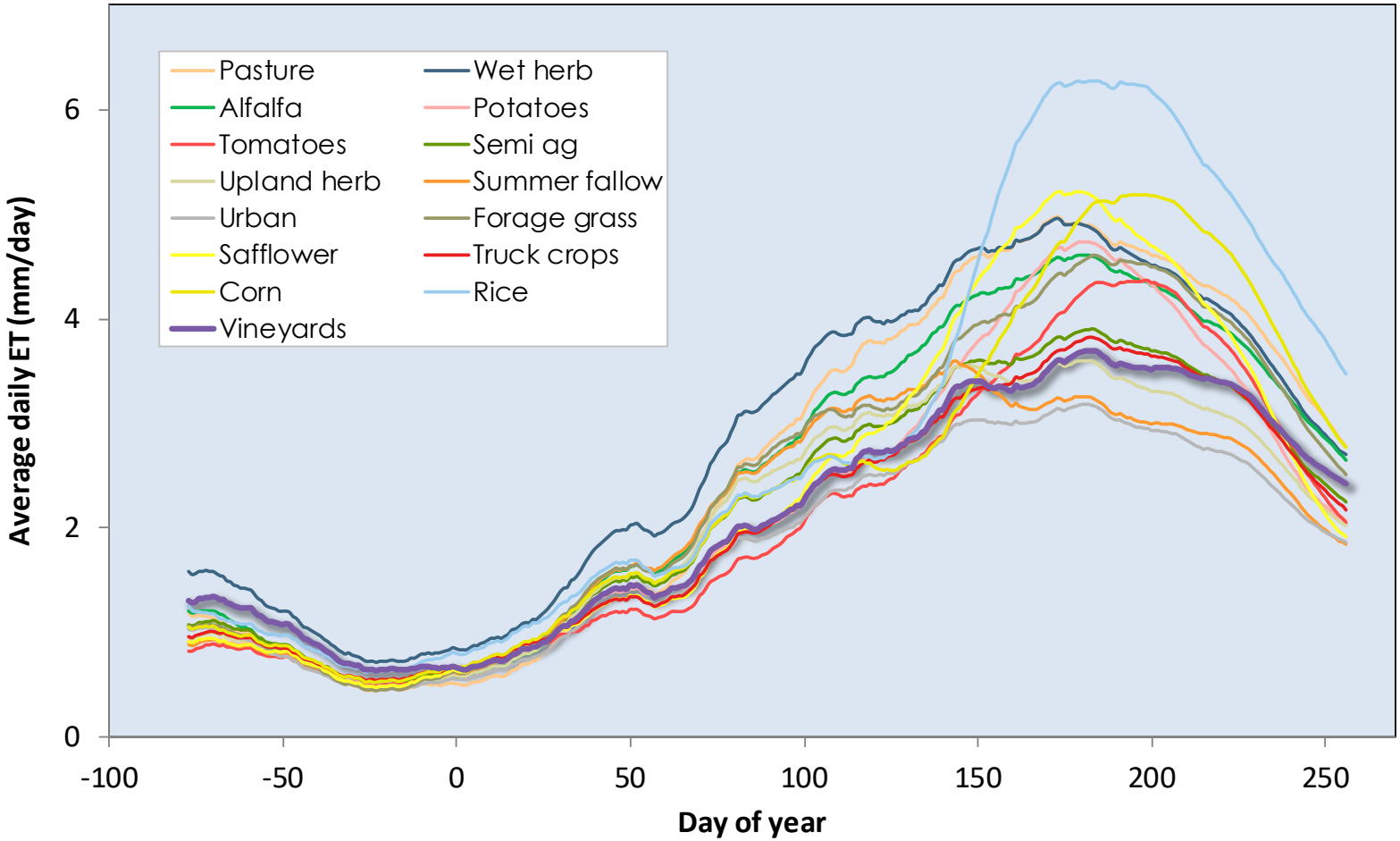
Water use (per unit area) by land use



Area-weighted water use by land use



Characteristic water use curves



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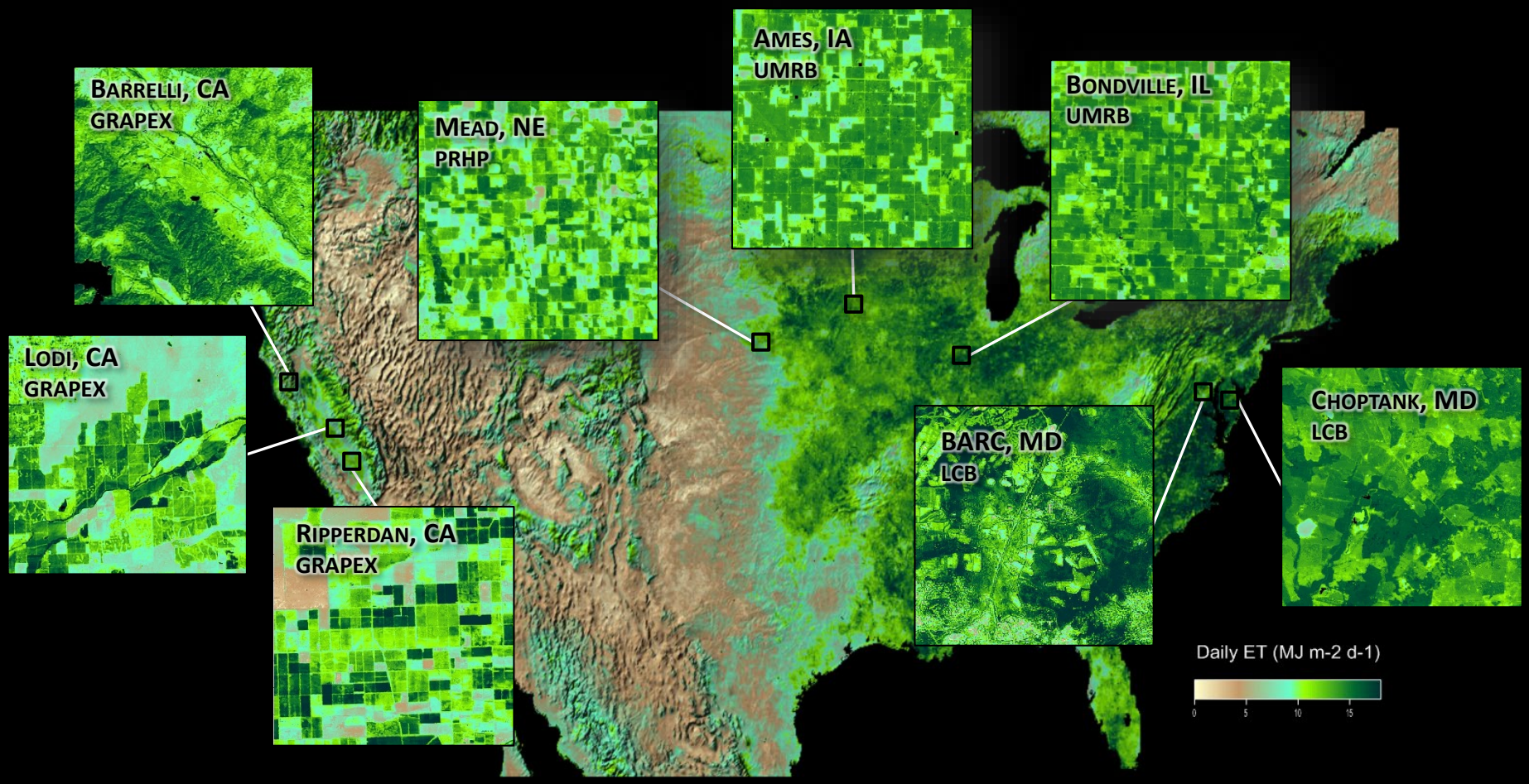

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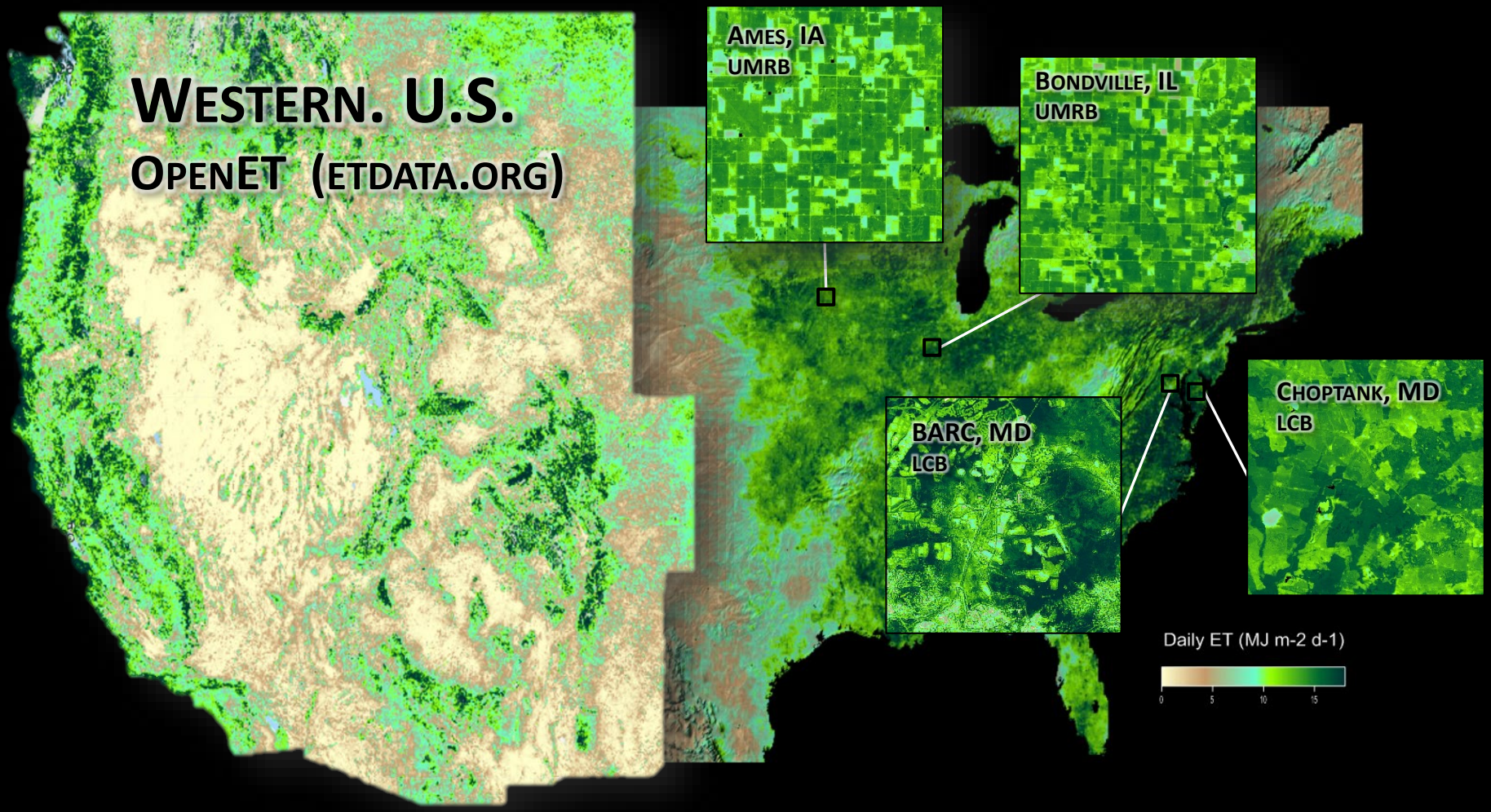

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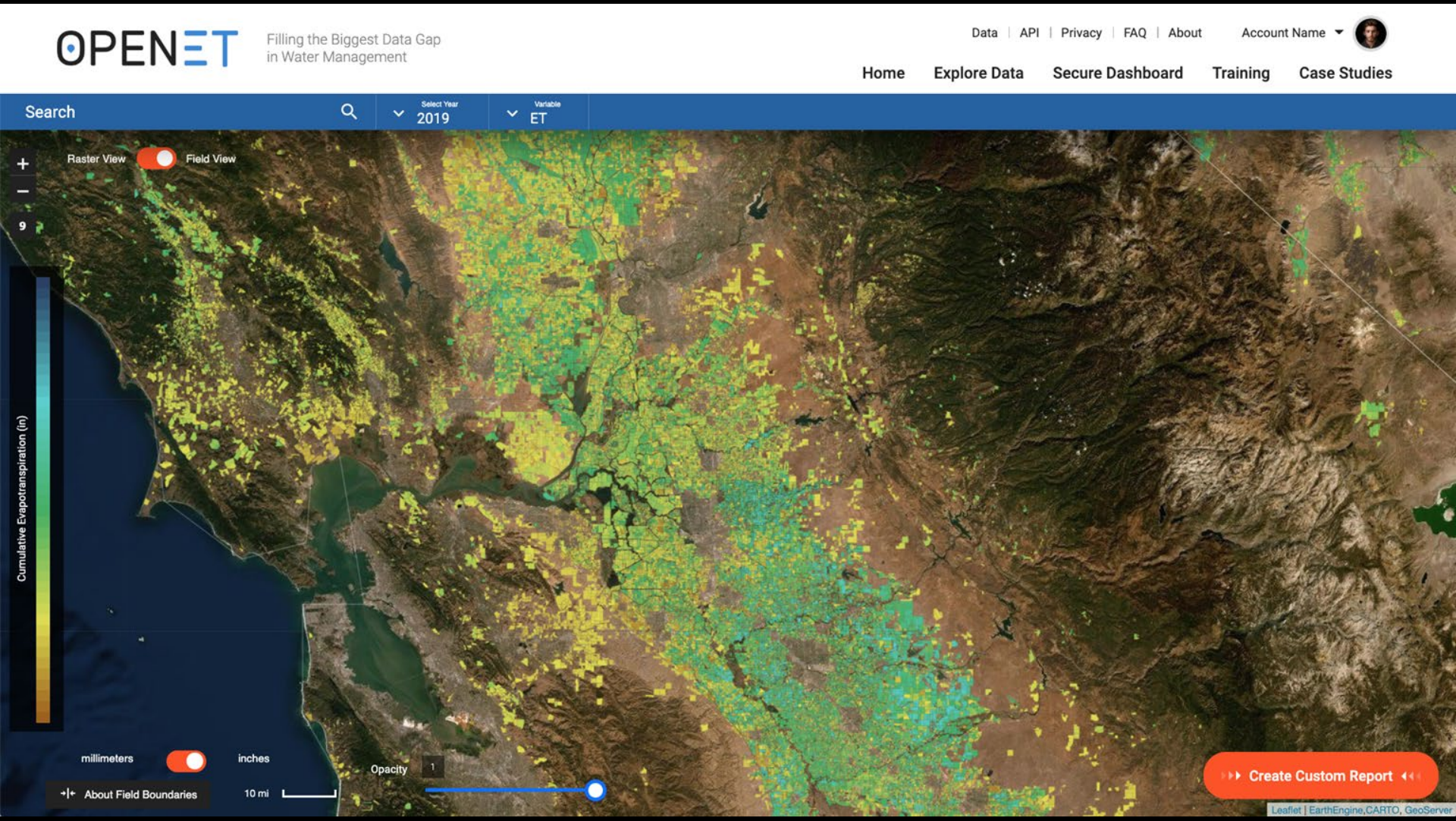
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Data | API | Privacy | FAQ | About
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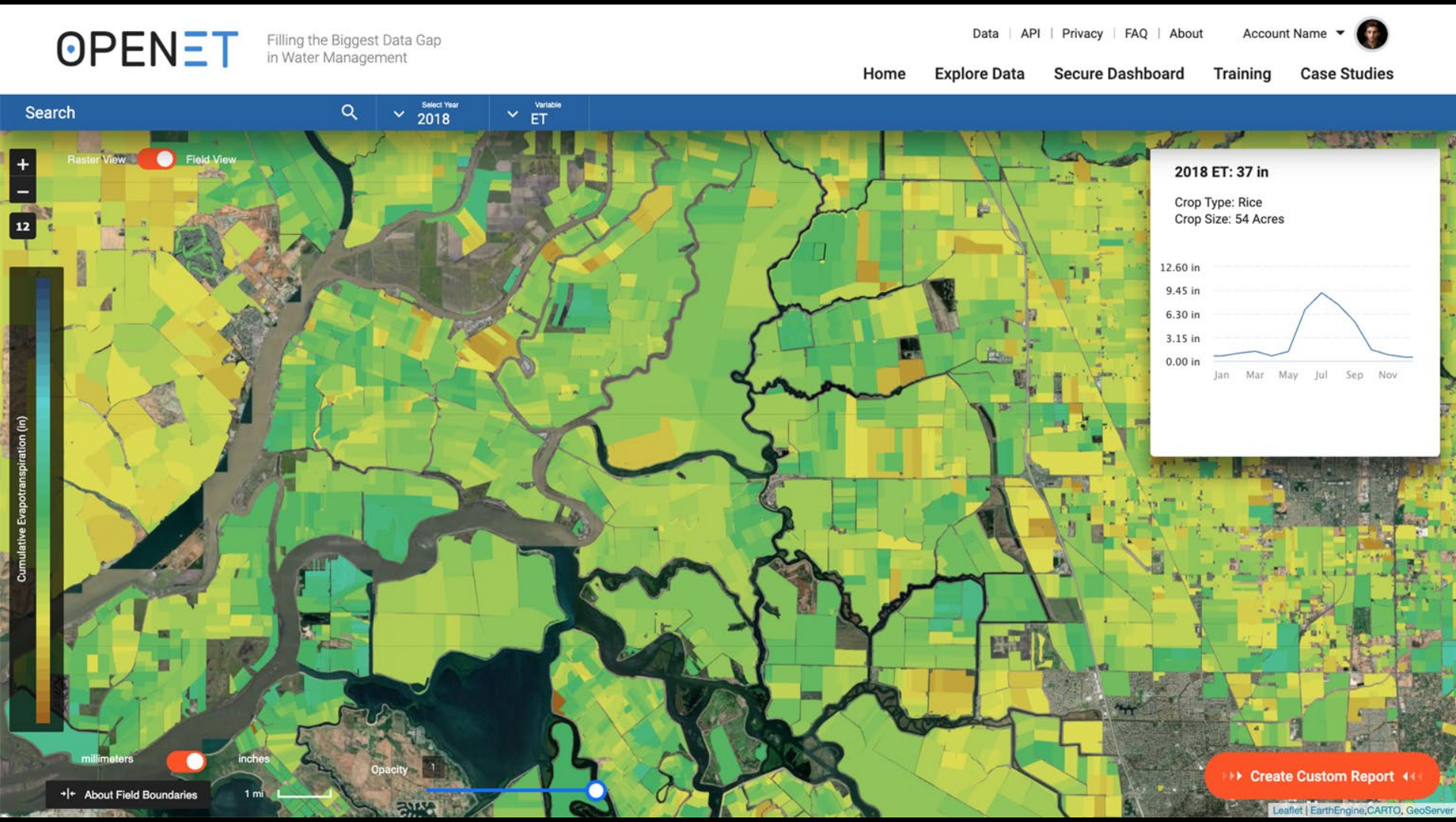
Home
Explore Data
Secure Dashboard
Training
Case Studies
Search
Select Year
2019
Variable
ET
Raster View
Field View
9
Cumulative Evapotranspiration (in)
millimeters
inches
About Field Boundaries
10 mi
Opacity
1
Create Custom Report
Leaflet | EarthEngine,CARTO, GeoServer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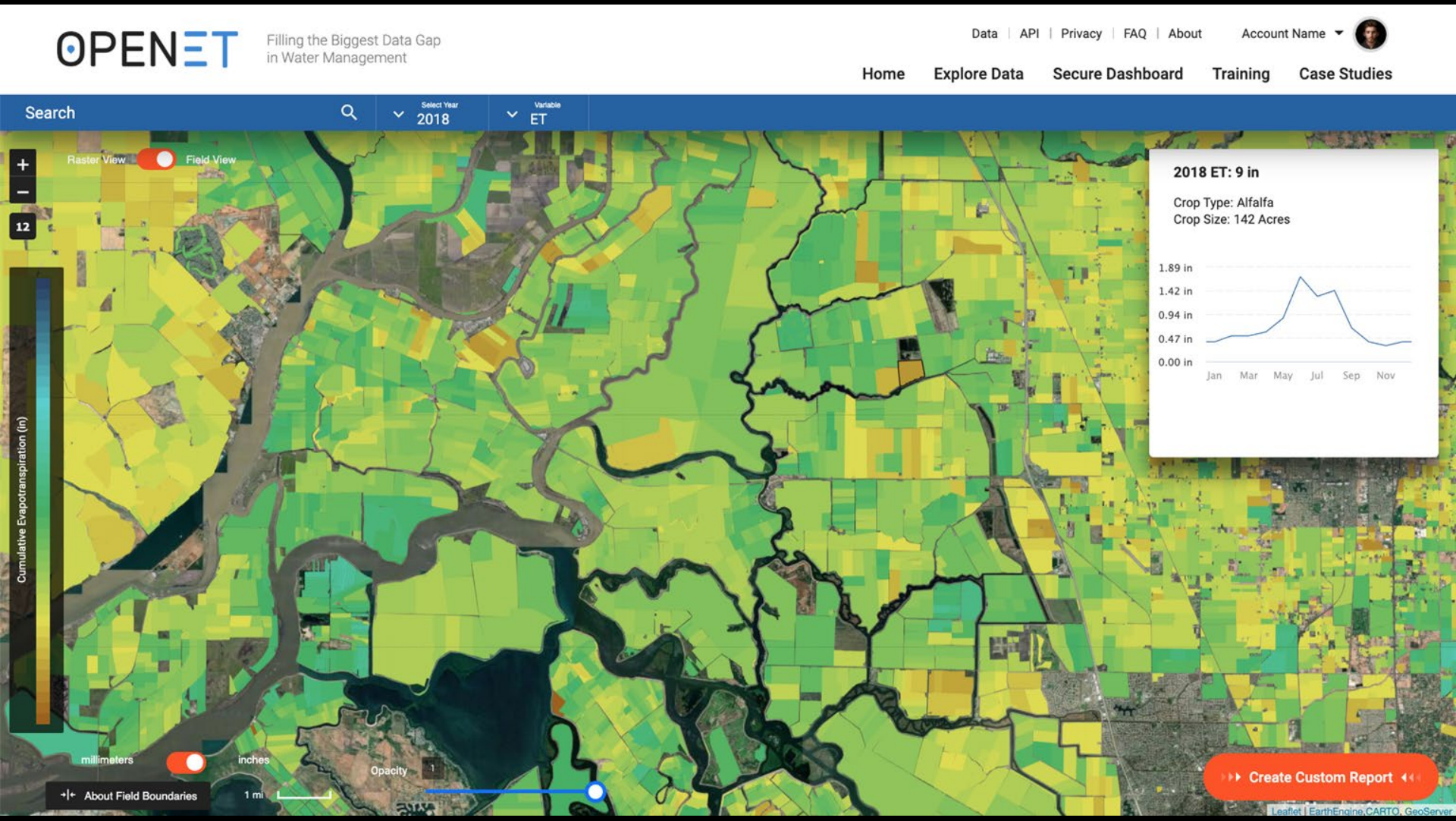
Home
Explore Data
Secure Dashboard
Training
Case Studies
Search
Select Year
2018
Variable
ET
Raster View
Field View
12
Cumulative Evapotranspiration (in)
2018 ET: 37 in
Crop Type: Rice
Crop Size: 54 Acres
12.60 in
9.45 in
6.30 in
3.15 in
0.00 in
Jan
Mar
May
Jul
Sep
Nov
millimeters
inches
Opacity
1
About Field Boundaries
1 mi
Create Custom Report
Leaflet | EarthEngine,CARTO, GeoServer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Home
Explore Data
Secure Dashboard
Training
Case Studies
Search
Select Year
2018
Variable
ET
Raster View
Field View
12
Cumulative Evapotranspiration (in)
2018 ET: 9 in
Crop Type: Alfalfa
Crop Size: 142 Acres
1.89 in
1.42 in
0.94 in
0.47 in
0.00 in
Jan
Mar
May
Jul
Sep
Nov
millimeters
inches
Opacity
1
About Field Boundaries
1 mi
Create Custom Report
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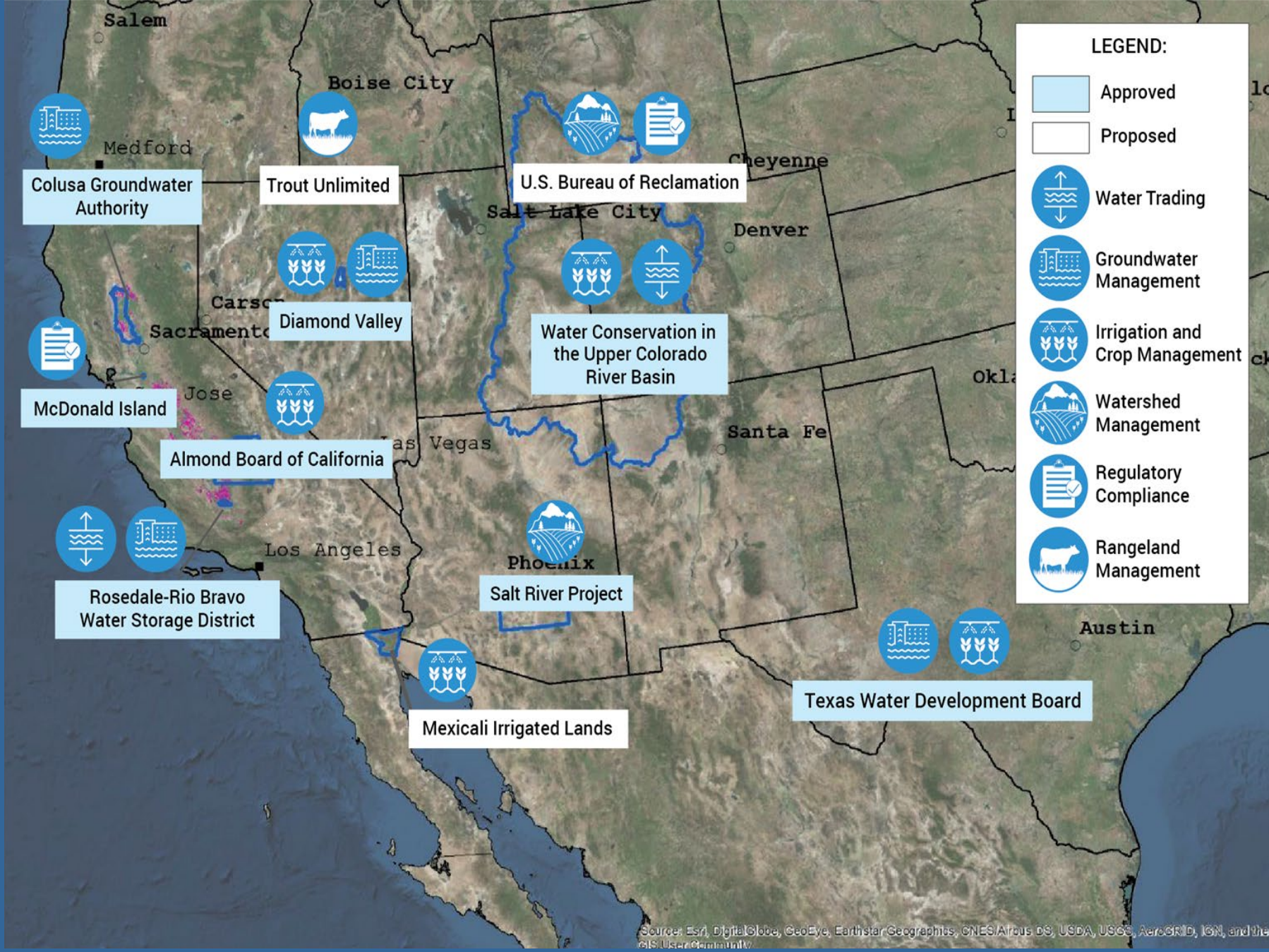
OpenET partners and use cases



Conclusions

Satellite Evapotranspiration

- Improved accounting of current water use and crop water productivity (crop per drop)
- Monitoring changes in water use with changing climate, land-use and population
- Improved hydrologic monitoring (flood, drought, runoff) to better cope with extremes
- Crop stress detection and yield estimation

hrsl.arsusda.gov/drought

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