



Mapping vineyard water use and stress with satellite remote sensing

Martha C. Anderson, Feng Gao, Kyle Knipper, Yun Yang, Liang Sun, Wayne Dulaney, Bill Kustas

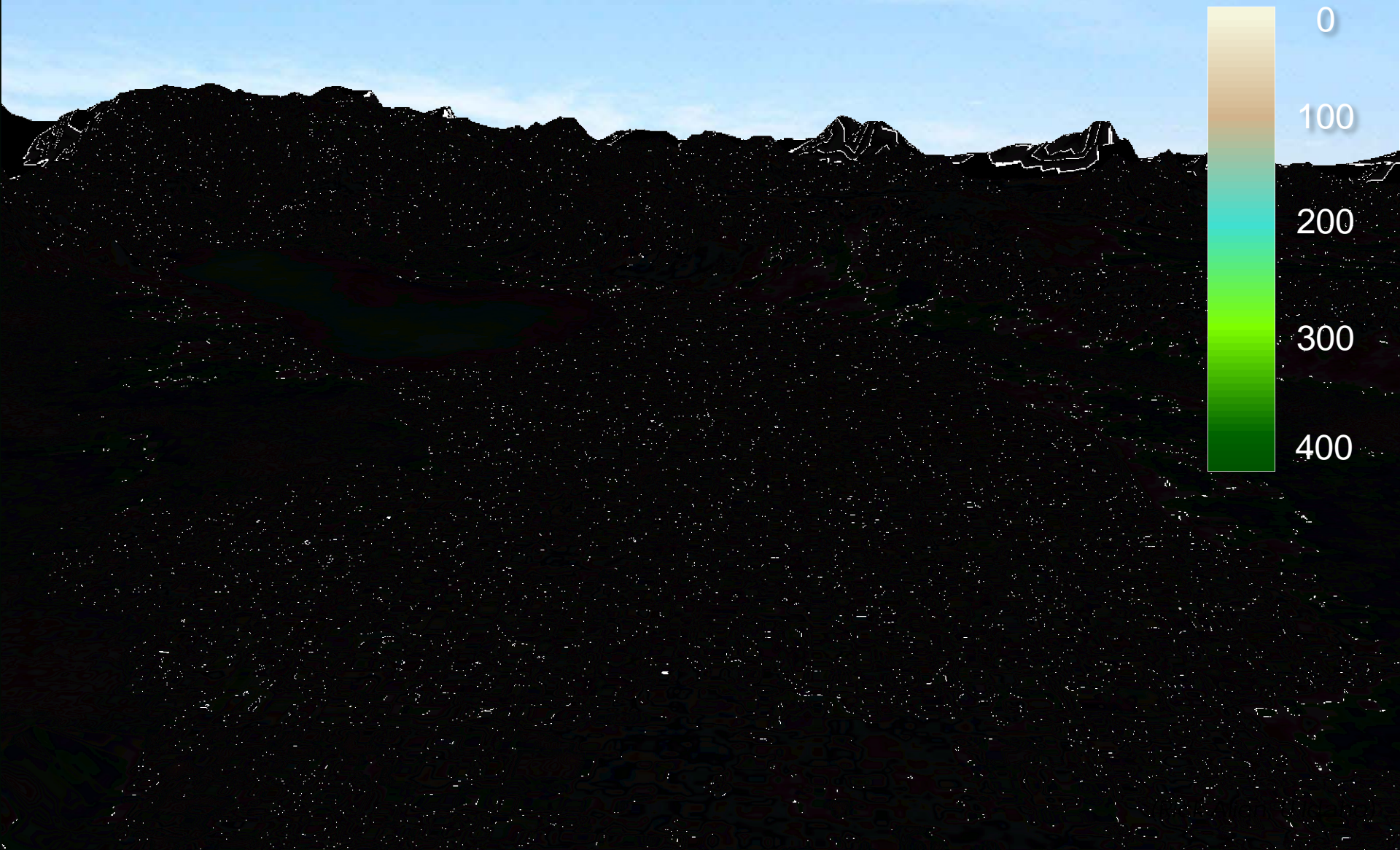
*USDA-Agricultural Research Service
Hydrology and Remote Sensing Laboratory
Beltsville, MD*

Chris Hain

NASA- MSFC

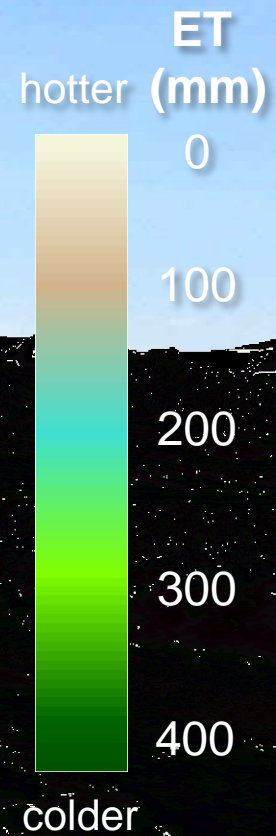
EVAPOTRANSPIRATION (ET)

Soil evaporation + plant transpiration



Primary satellite input:

Thermal infrared maps of land-surface temperature
(wetter evaporating surfaces tend to be cooler)

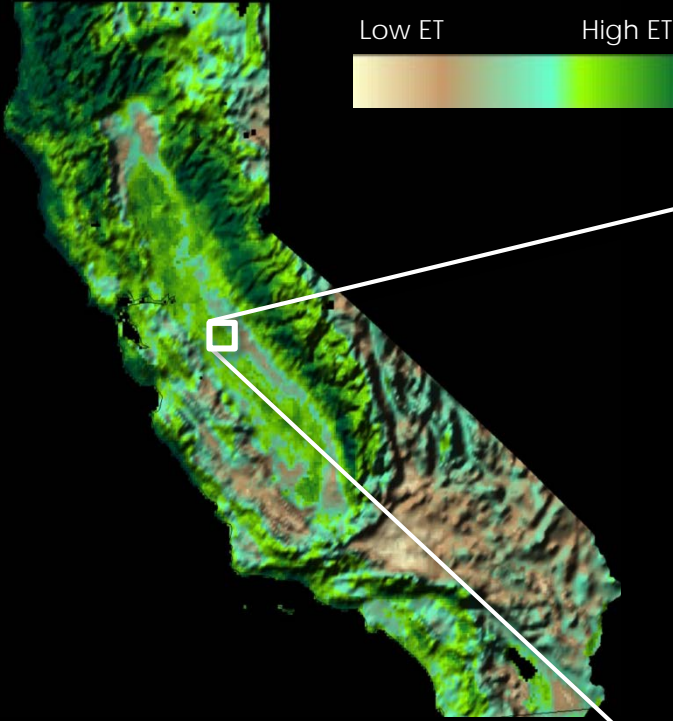
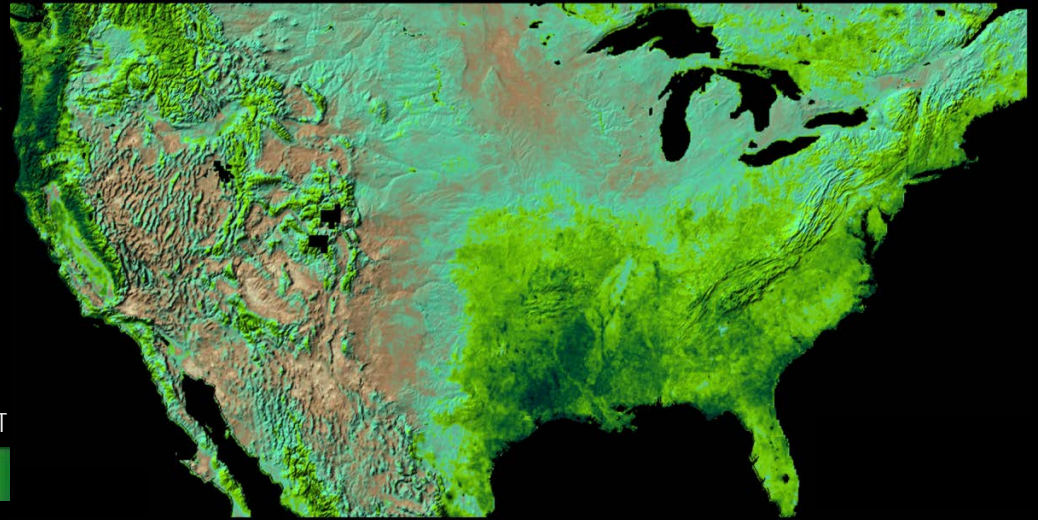


Multi-sensor evapotranspiration

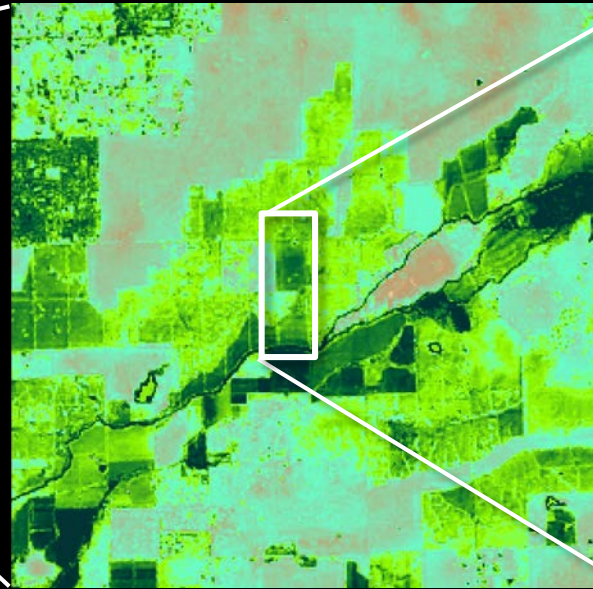
NOAA Geostationary Operational Environmental Satellites

International geostationary constellation

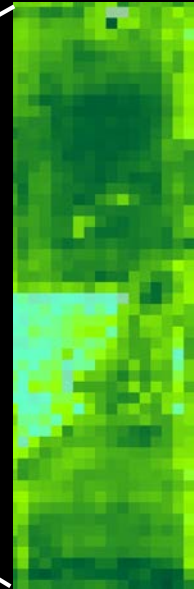
GOES - West



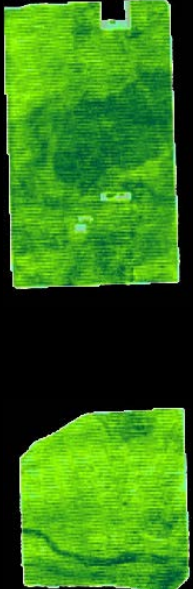
GOES/MODIS/Landsat fusion



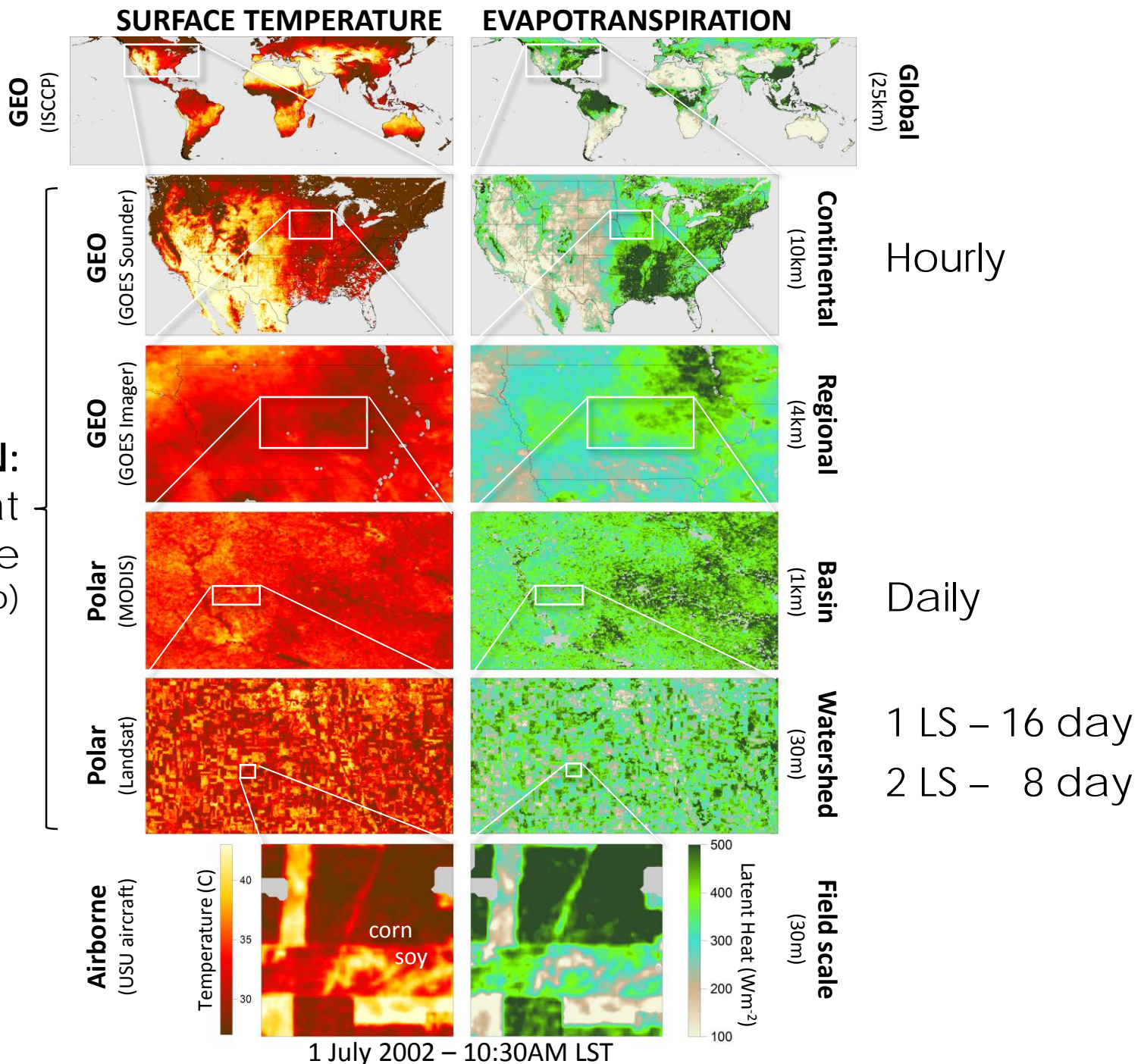
Landsat



Aircraft

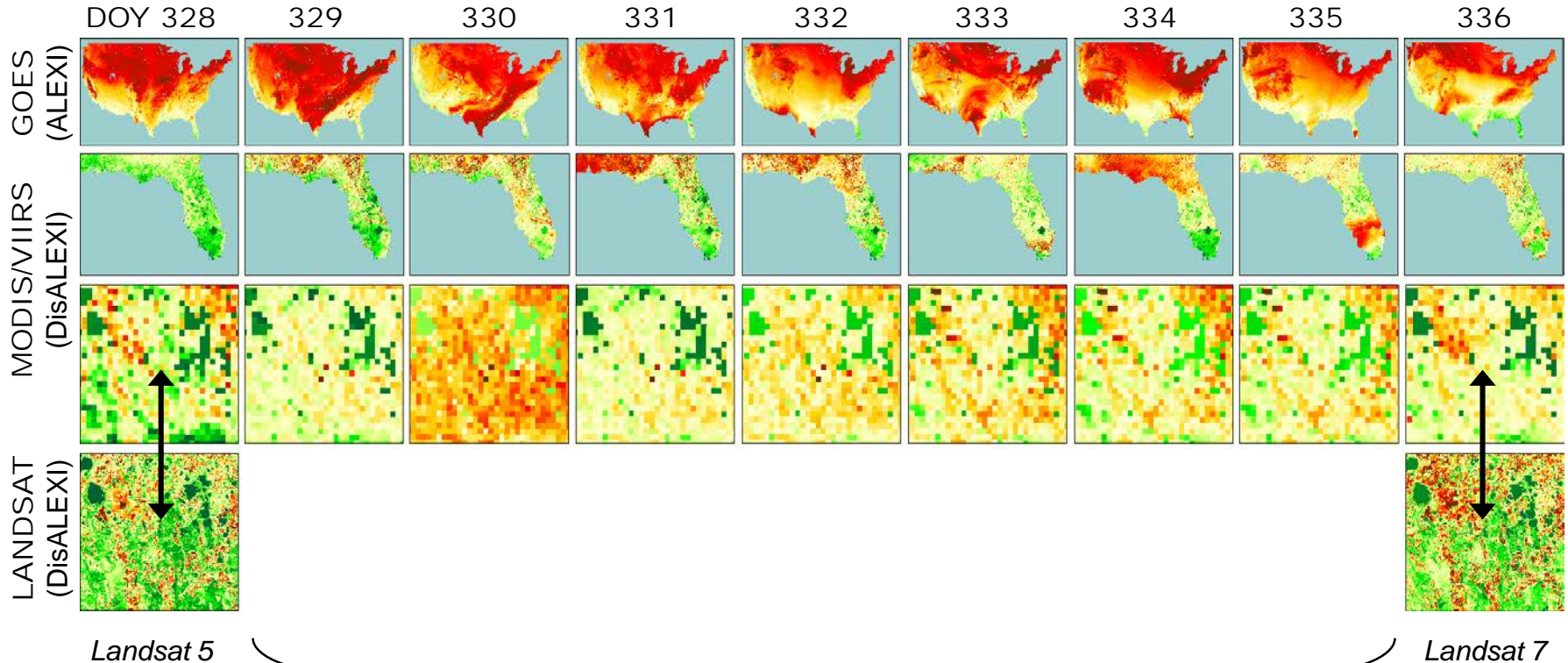


DATA FUSION:
daily ET at
field scale
(F. Gao)



GOES/MODIS/Landsat FUSION

Daily Evapotranspiration - Orlando, FL



Spatial Temporal Adaptive Reflectance Fusion Model
(STARFM) (Gao et al, 2006)



HIGH RESOLUTION ET DATACUBES

... water quality

... water use

... water security

The background of the slide is a composite image. On the left side, there is a stack of approximately 15 semi-transparent, overlapping images of a vineyard, creating a 3D effect. The main area on the right is a semi-transparent map overlay on a brownish aerial photograph of a vineyard. The map shows a network of lines, likely representing irrigation canals or field boundaries. The text is overlaid on this map area.

ET FOR VINEYARD IRRIGATION

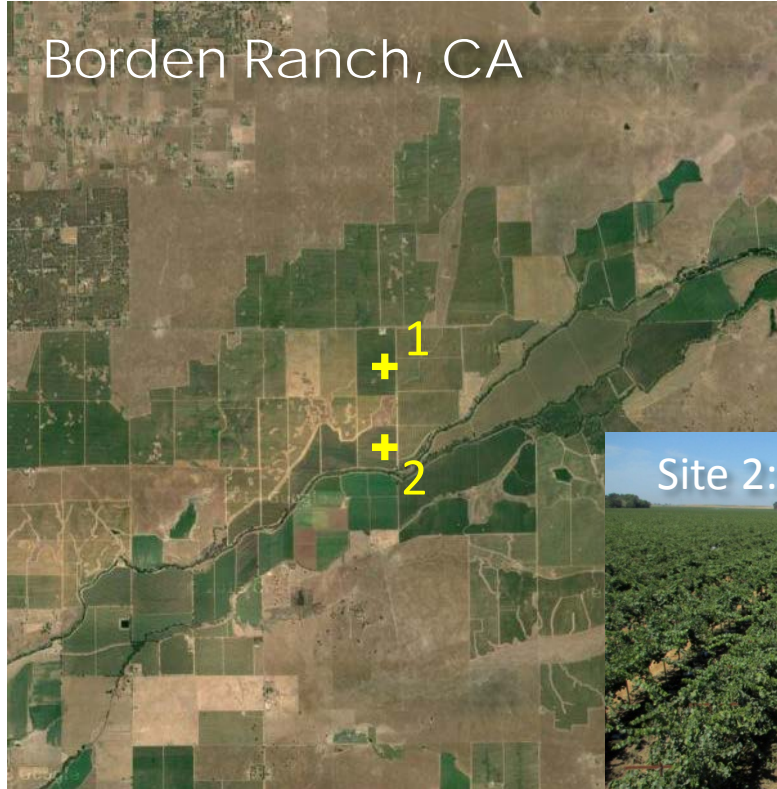
... when to start

... how much to apply

*... preemptive heat
wave applications*

GRAPEX

GRAPE REMOTE SENSING ATMOSPHERIC PROFILE AND EVAPOTRANSPIRATION EXPERIMENT



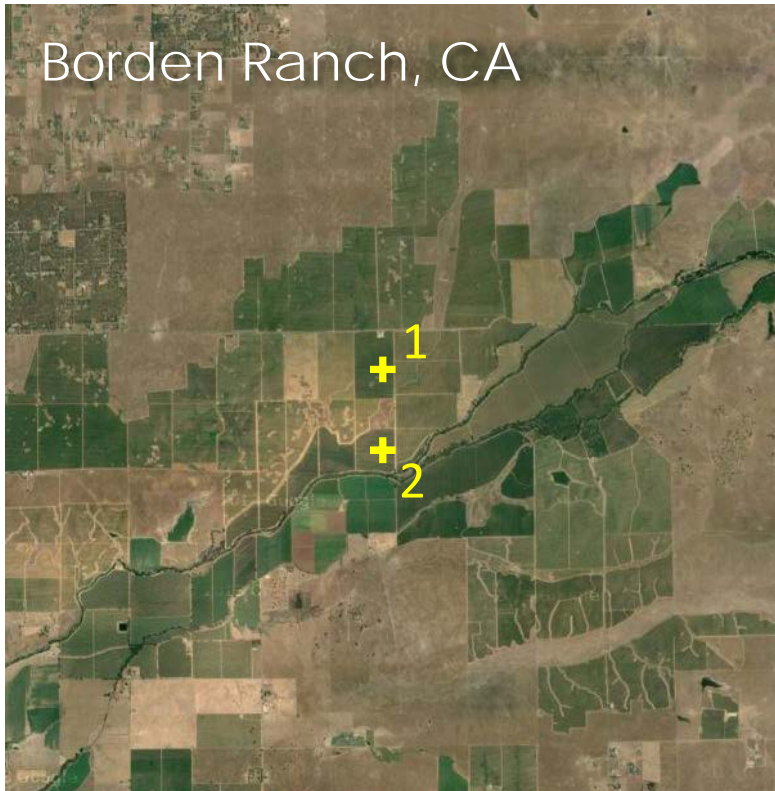
GRAPEX 2013-2017



GRAPEX

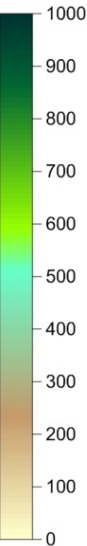
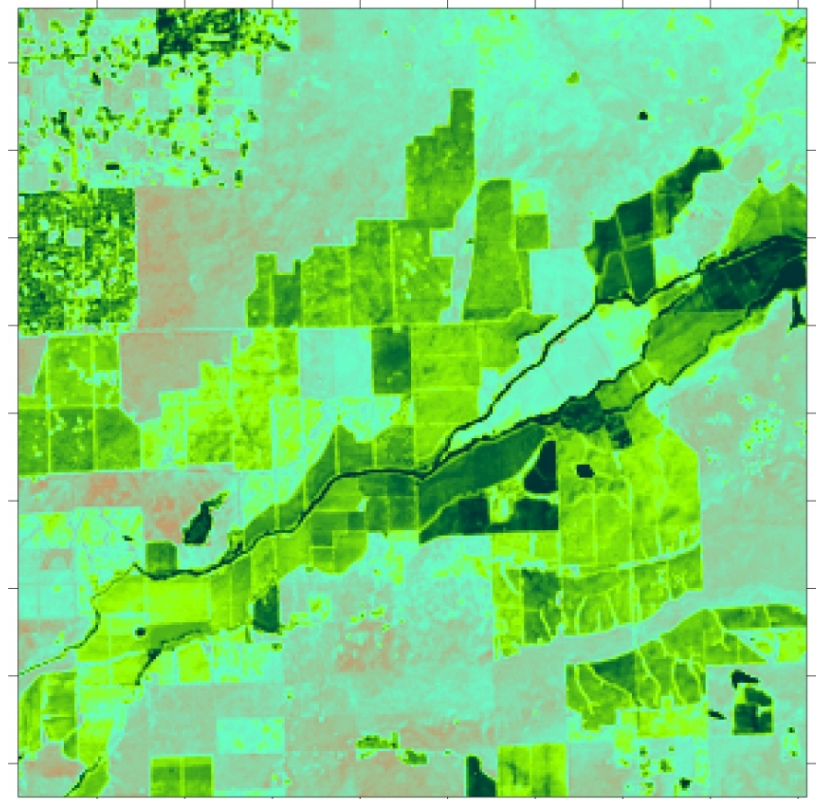
GRAPE REMOTE SENSING ATMOSPHERIC PROFILE AND EVAPOTRANSPIRATION EXPERIMENT

Borden Ranch, CA



Cumulative ET (mm)

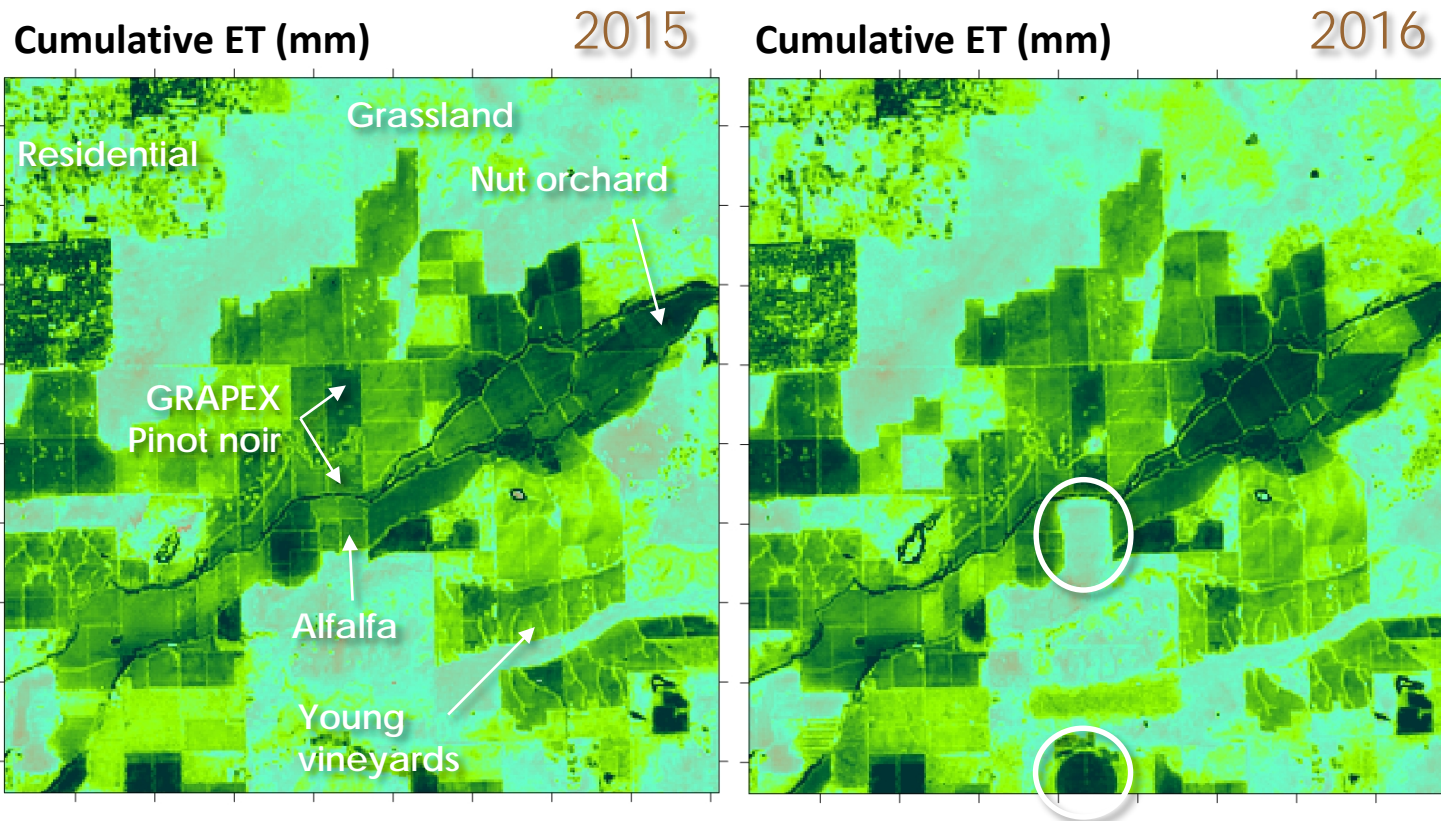
250



Landsat 8 - 2013

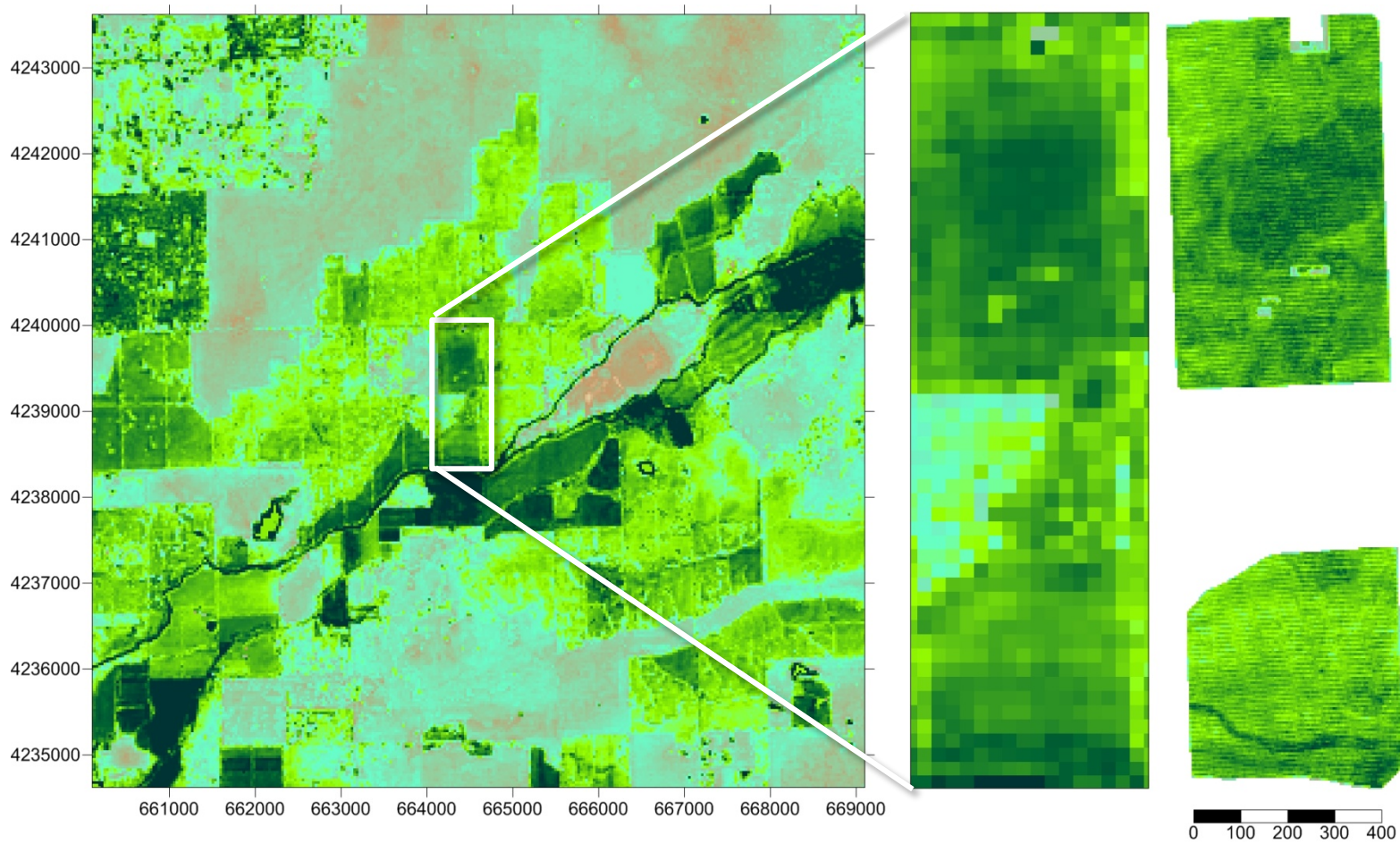
Semmens, K.A., et al.(2015). Monitoring daily evapotranspiration over two California vineyards using Landsat 8 in a multi-sensor data fusion approach. *Remote Sens. Environ.*, doi:10.1016/j.rse.2015.1010.1025

GRAPEX, Borden Ranch CA



Water use for irrigation

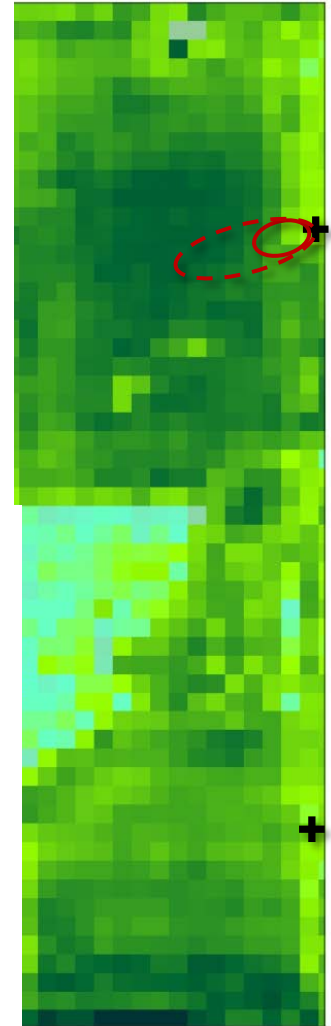
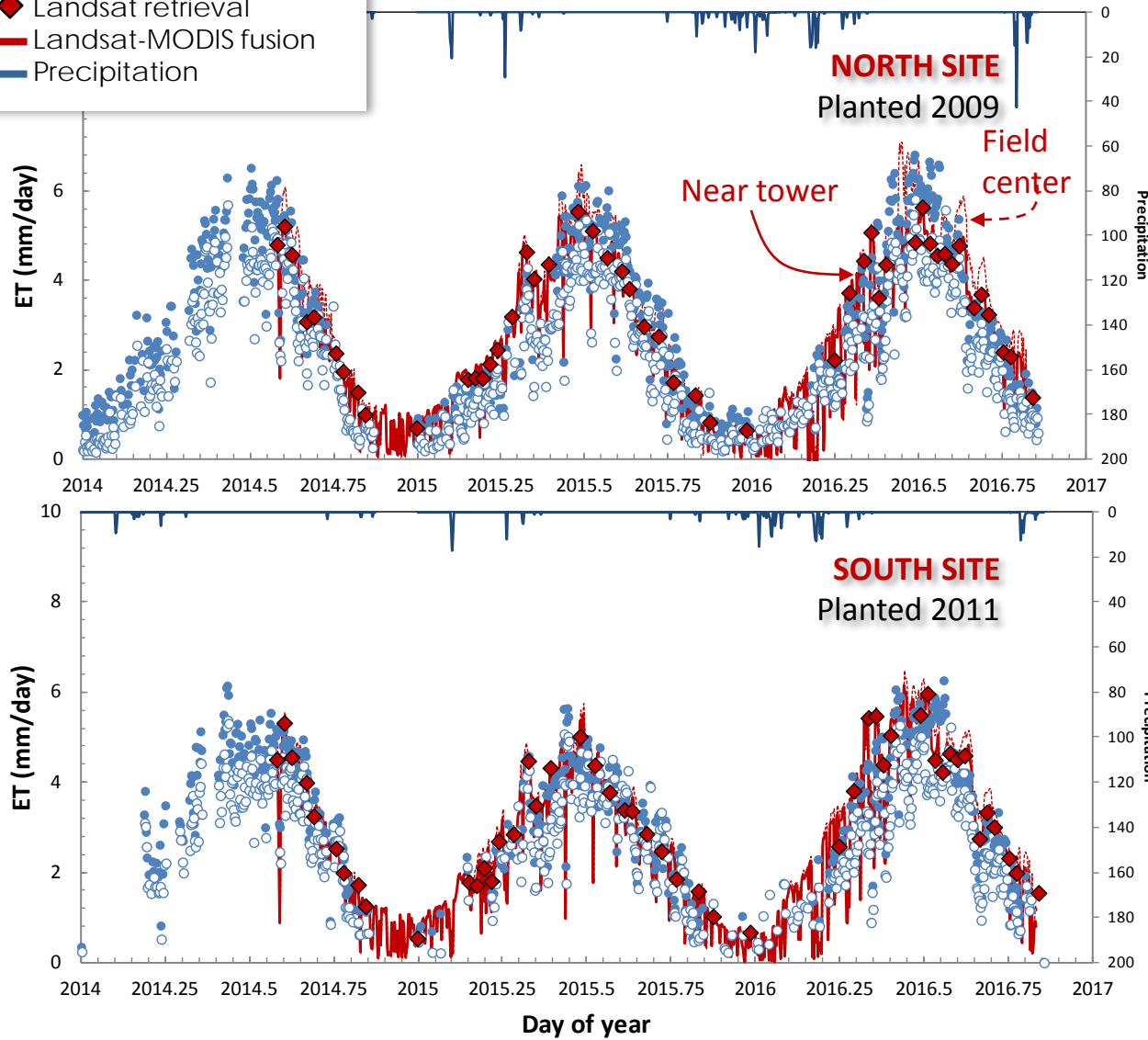
Utility of aircraft thermal imaging

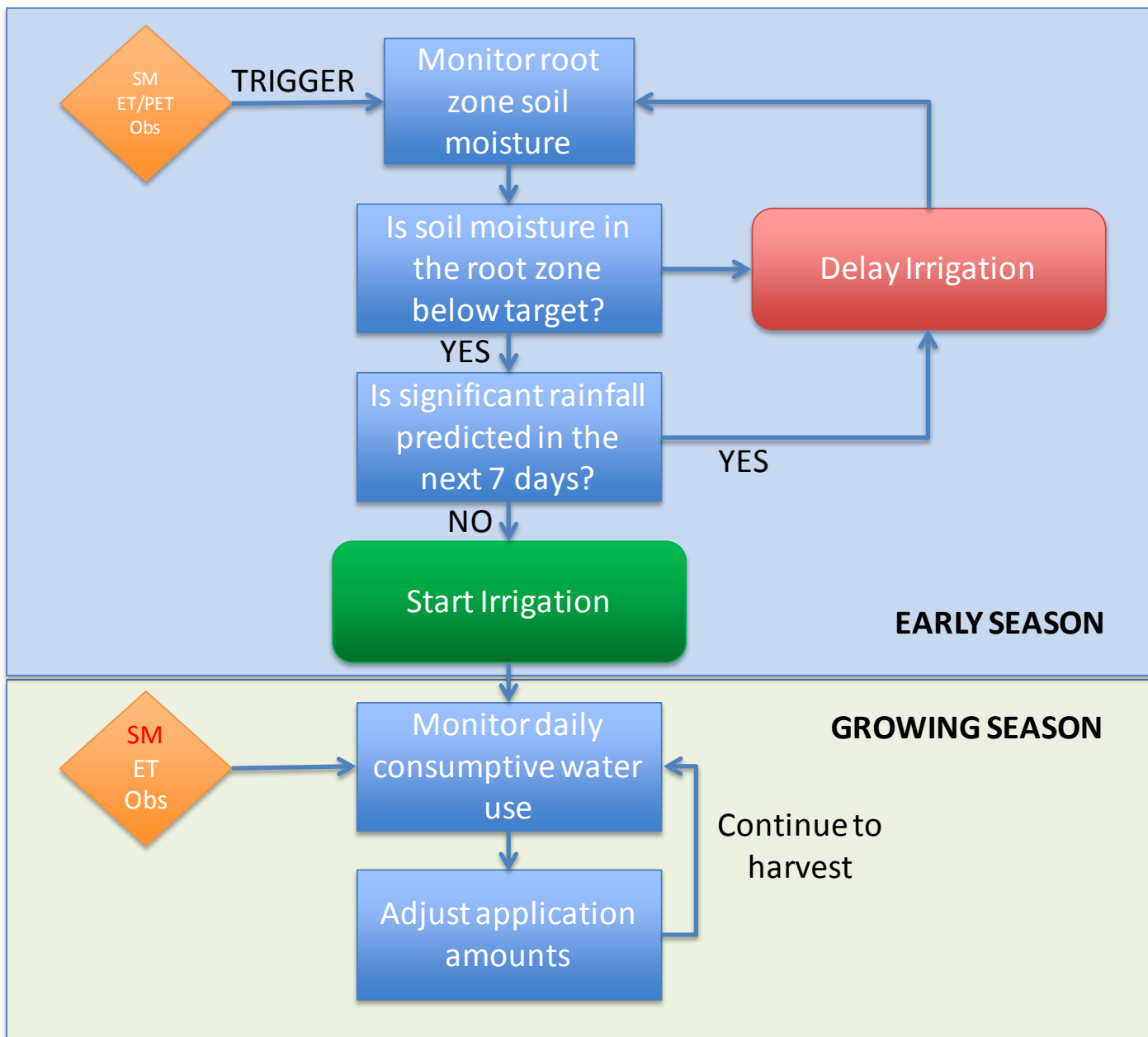


June 12, 2013

Comparison with tower measurements

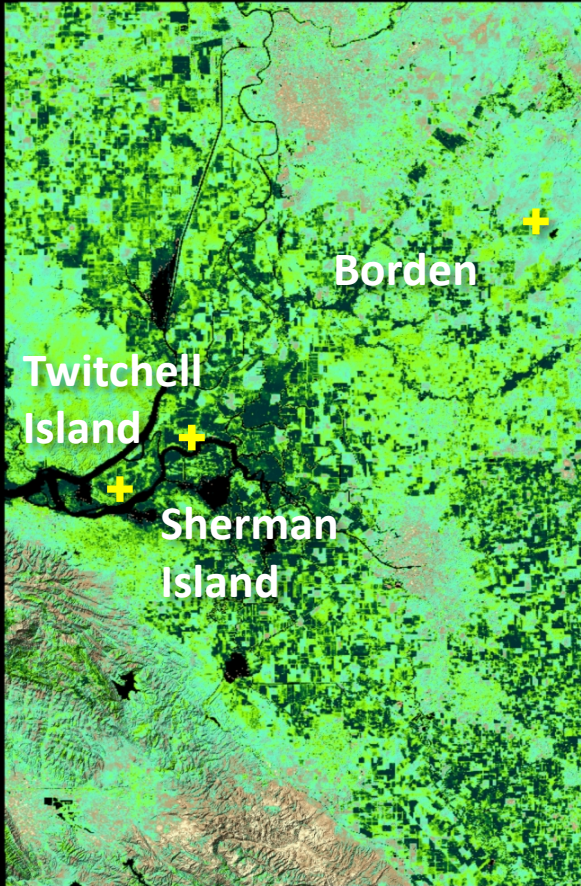
- Observed ET
- ◆ Landsat retrieval
- Landsat-MODIS fusion
- Precipitation





SACRAMENTO – SAN JOAQUIN DELTA ET INTERCOMPARISON STUDY

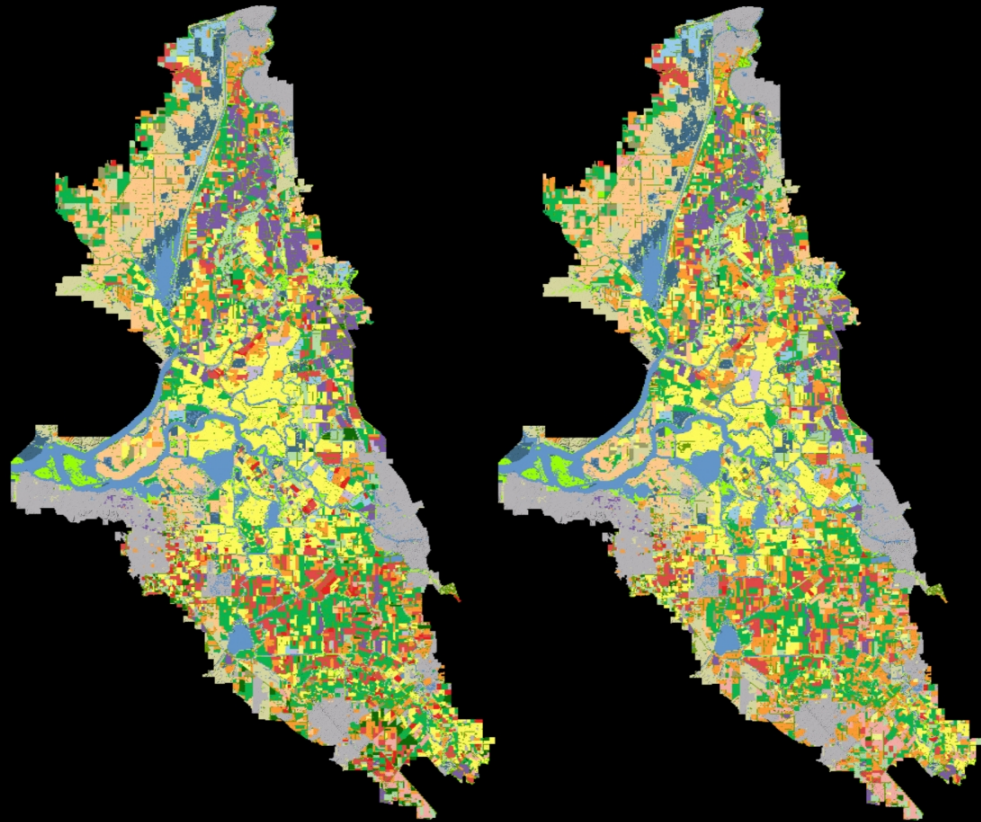
10day ET (mm) 2015200



2015

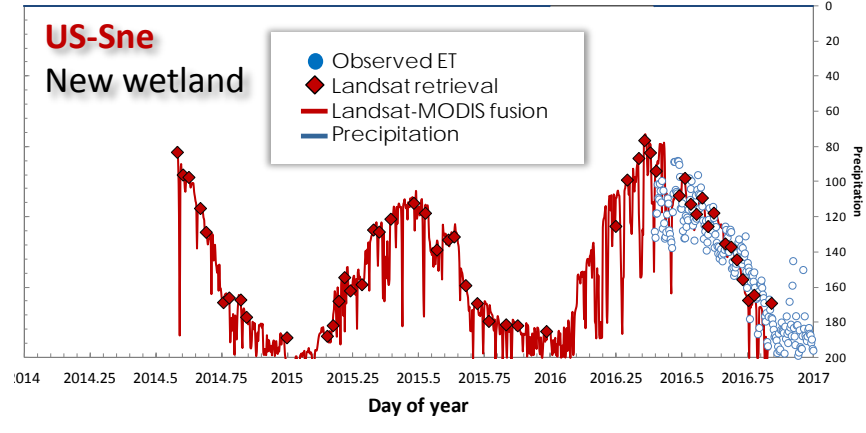
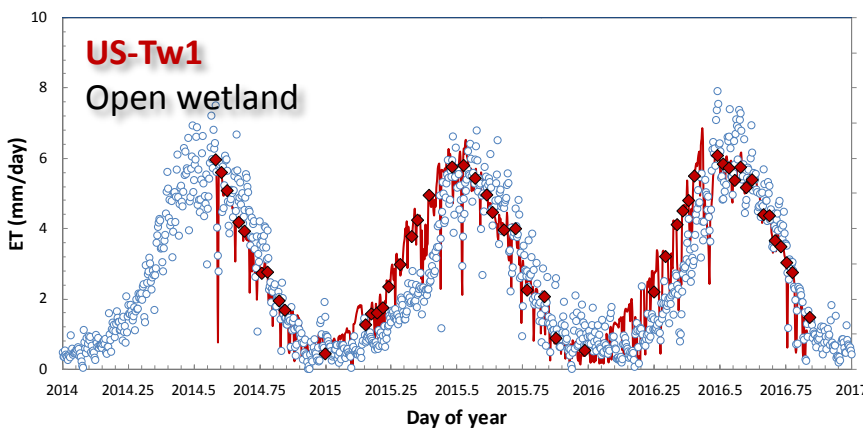
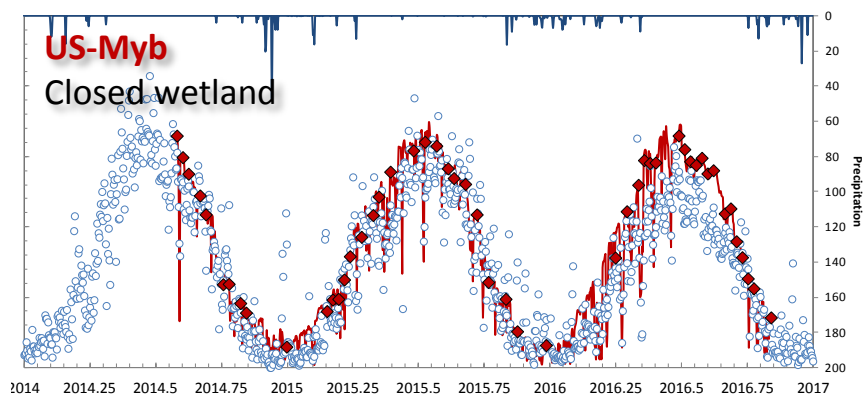
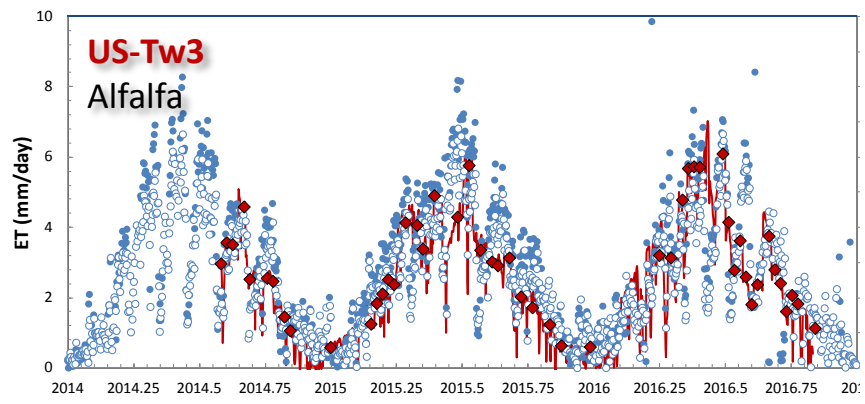
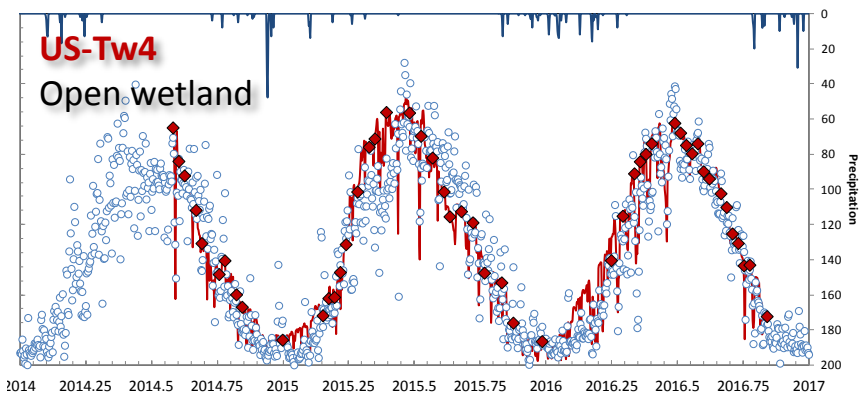
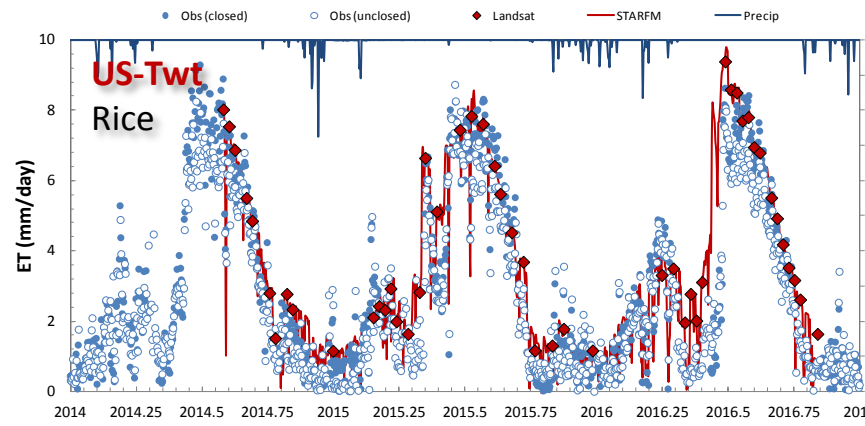
Landuse

2016

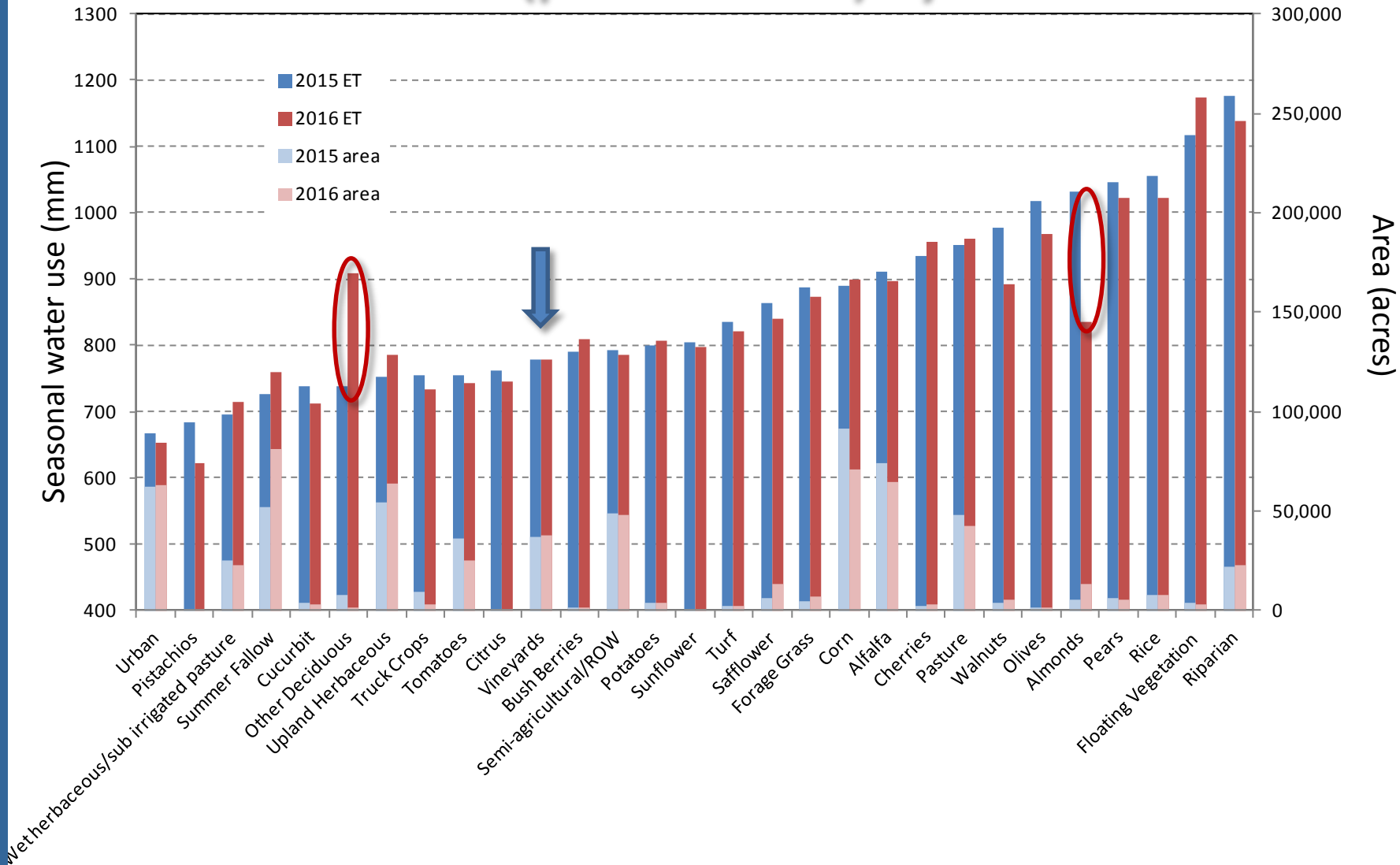


- | | | |
|--------------|---------------|-------------|
| Corn | Rice | Tomatoes |
| Alfalfa | Summer fallow | Vineyards |
| Wetland | Forage grass | Urban |
| Pasture | Riparian | Almonds |
| Upland herb. | Water | Semi-ag/row |

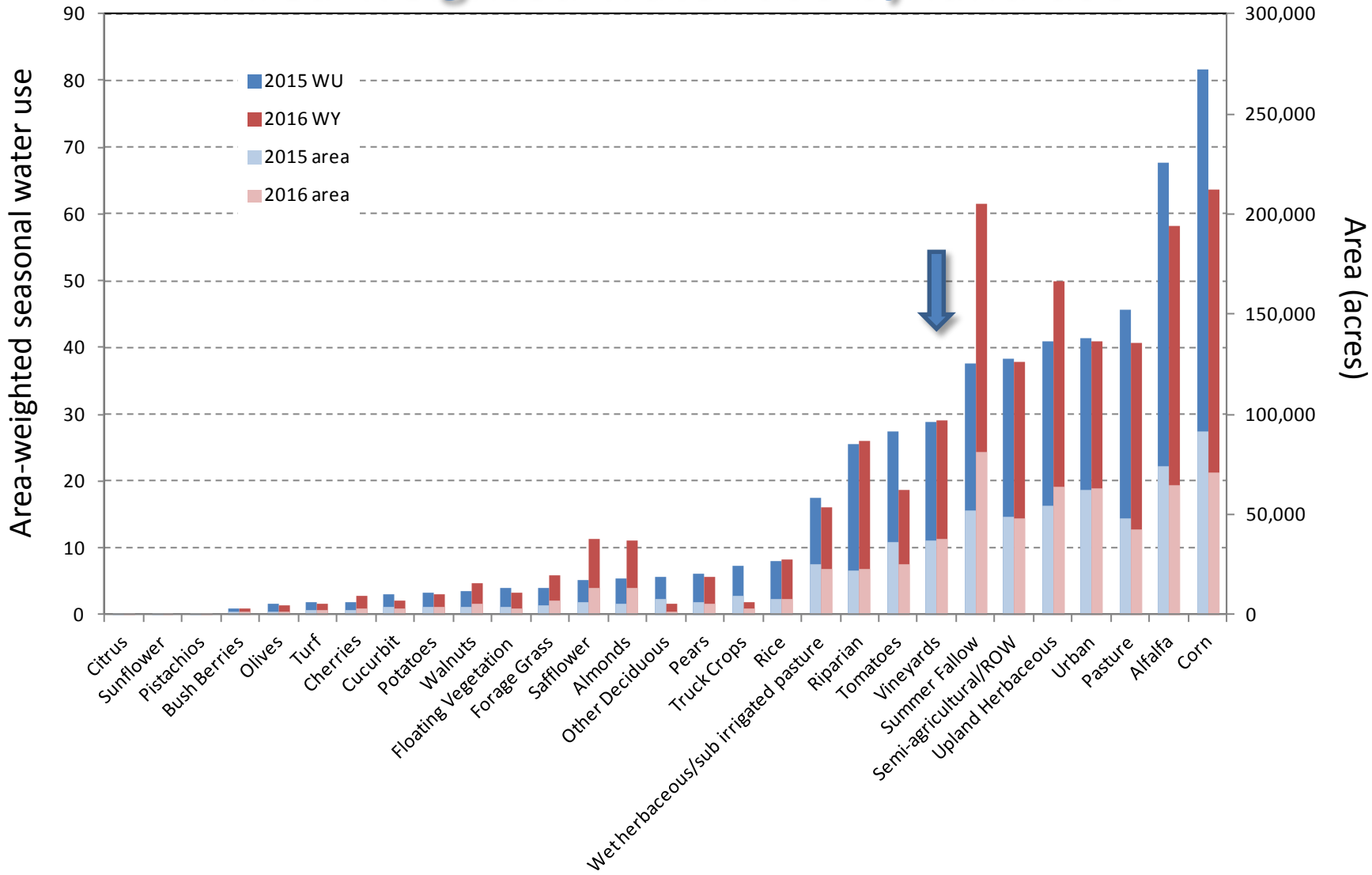
Comparison with tower measurements



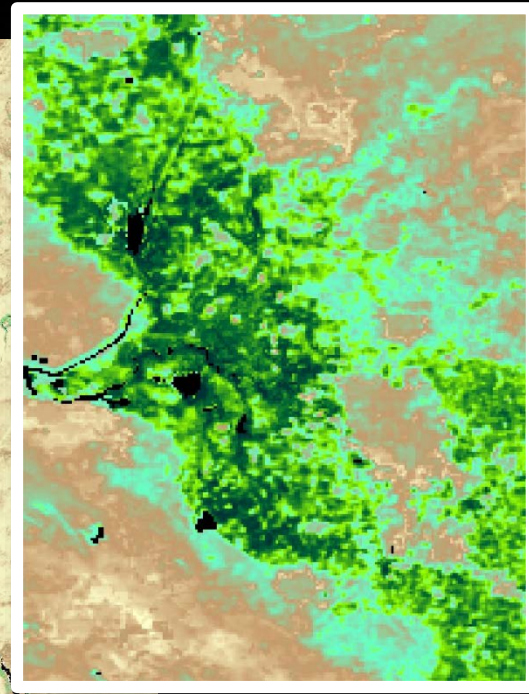
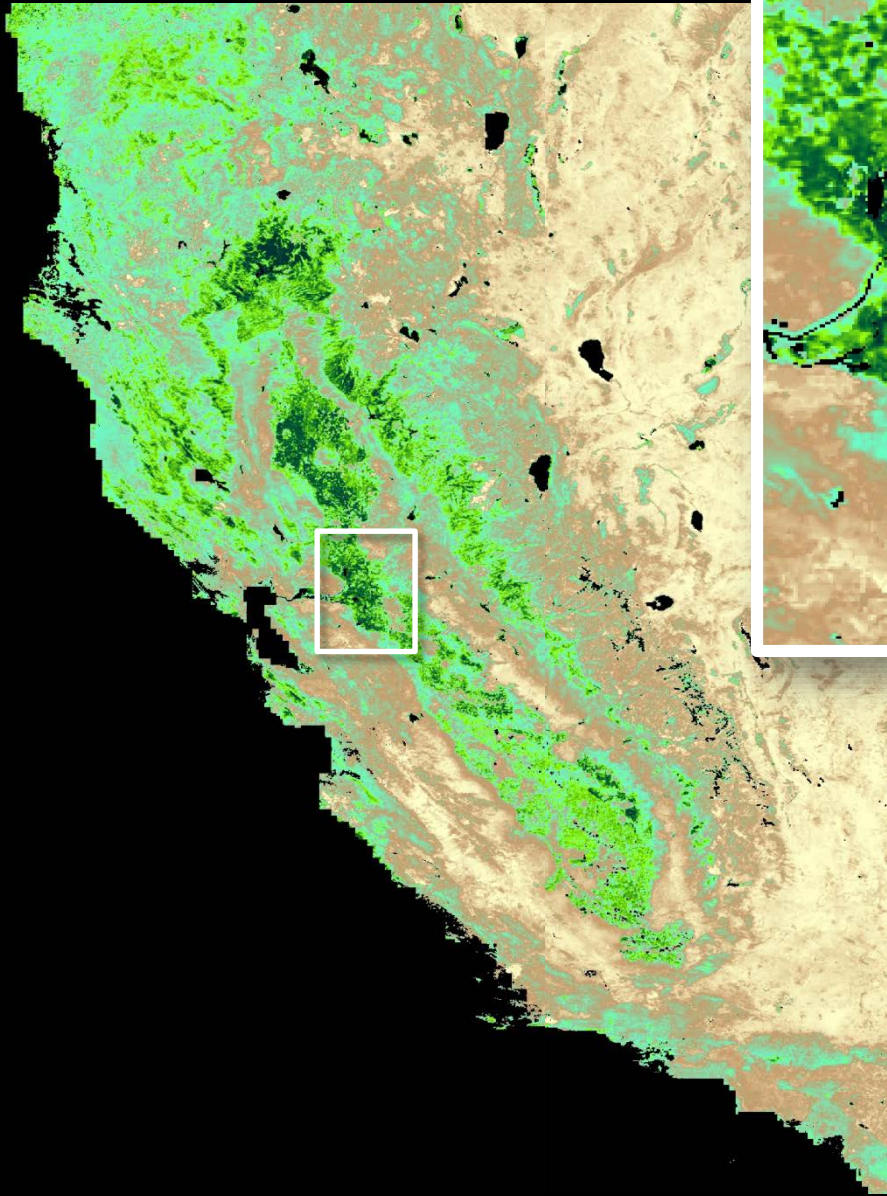
Water use (per unit area) by land use



Area-weighted water use by land use



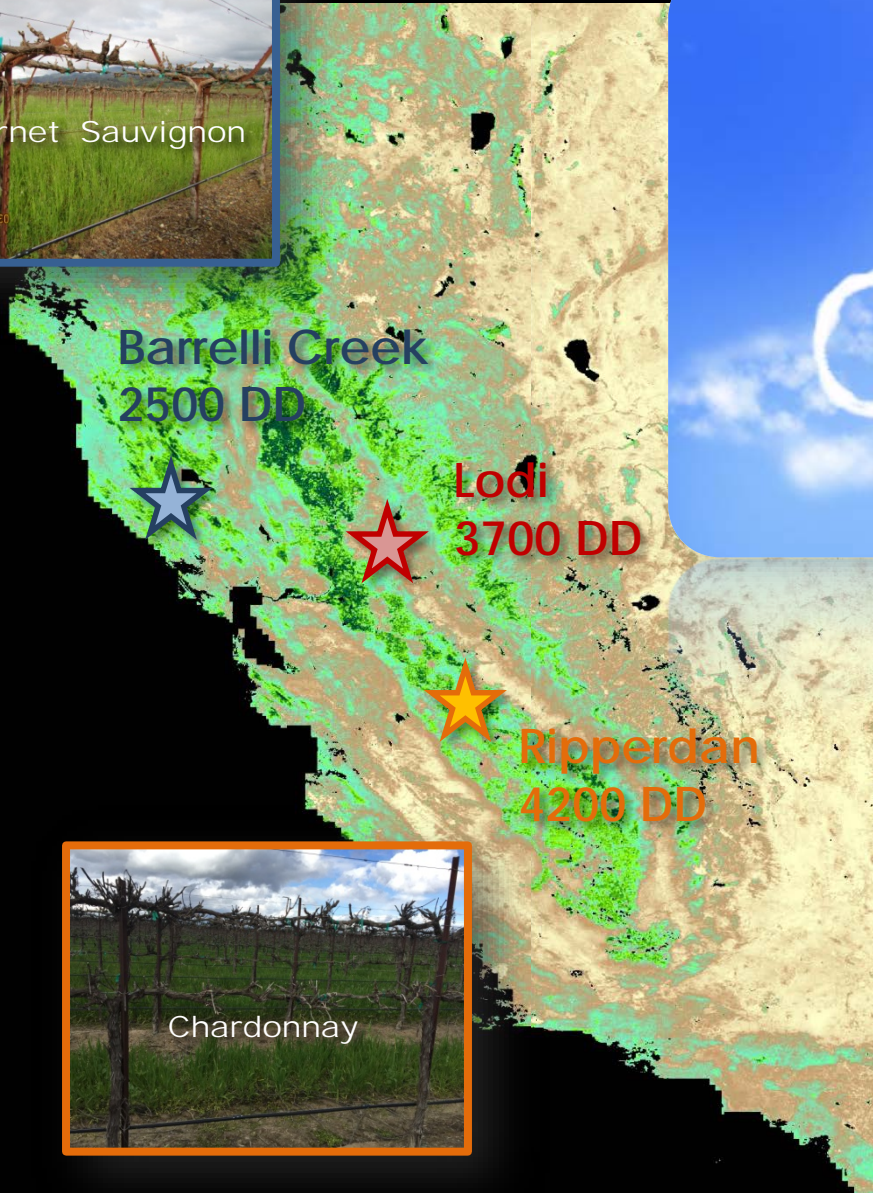
Expansion of GRAPEX coverage



New VIIRS ET product:

- 400 m resolution
- daily timestep
- western U.S.

Expansion of GRAPEX coverage



New GRAPEX locations

New VIIRS ET product:

- 400 m resolution
- daily timestep
- western U.S.

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

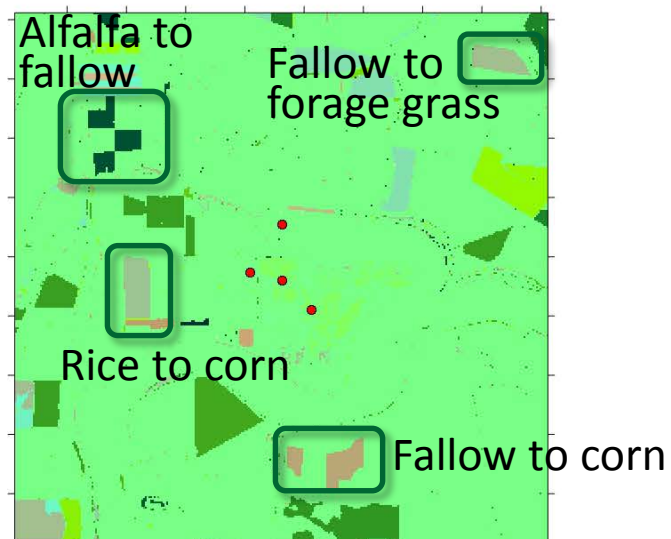
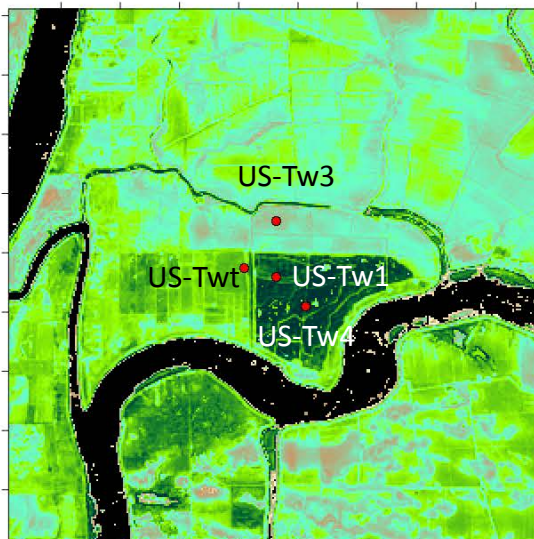
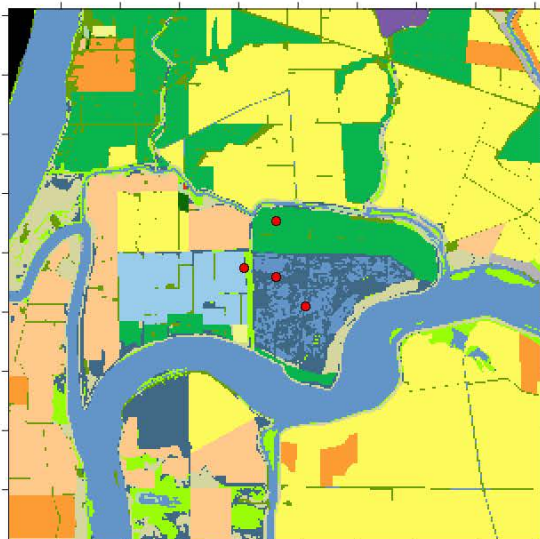
hrsl.arsusda.gov/drought

Land use class

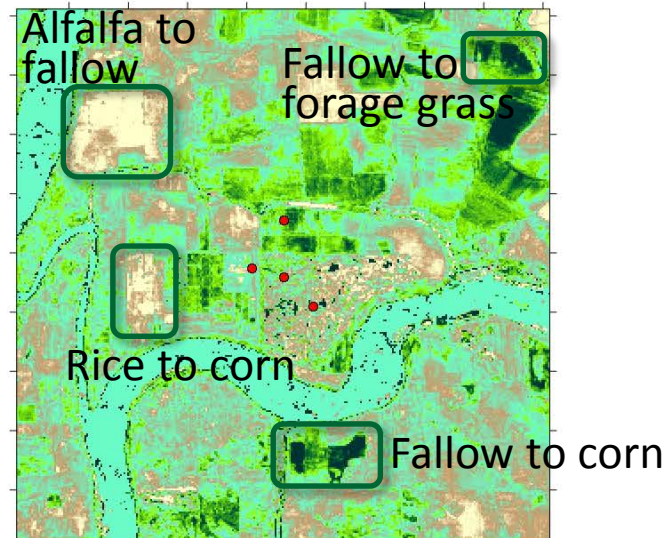
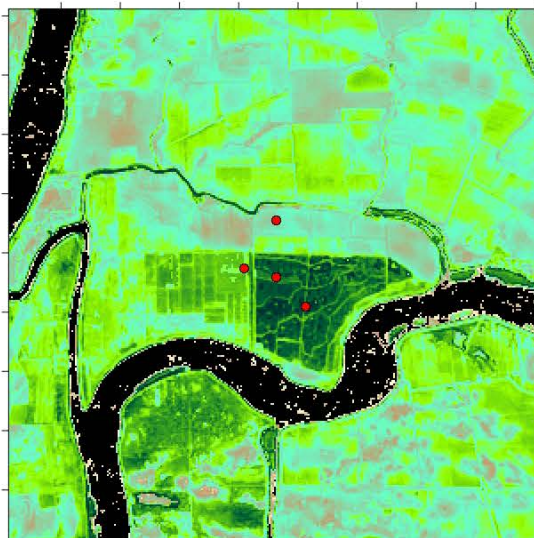
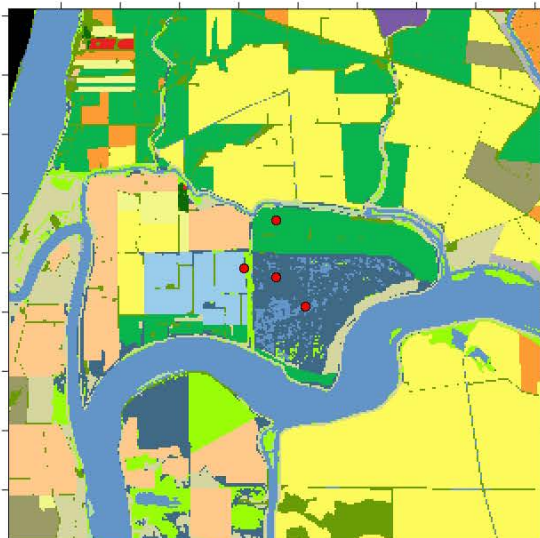
Cumulative ET (DOY 100-300)

Land use change (2016-2015)

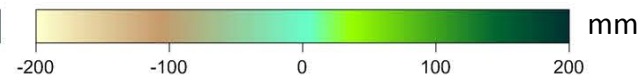
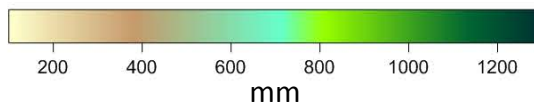
2015



2016



- | | | |
|--------------|---------------|-------------|
| Corn | Rice | Truck crops |
| Alfalfa | Summer fallow | |
| Wetland | Forage grass | |
| Pasture | Riparian | |
| Upland herb. | Water | |
| | Semi-ag/row | |



ET Difference (2016-2015)

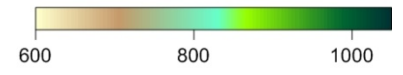
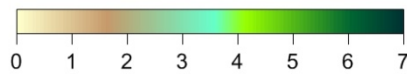
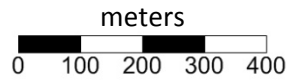
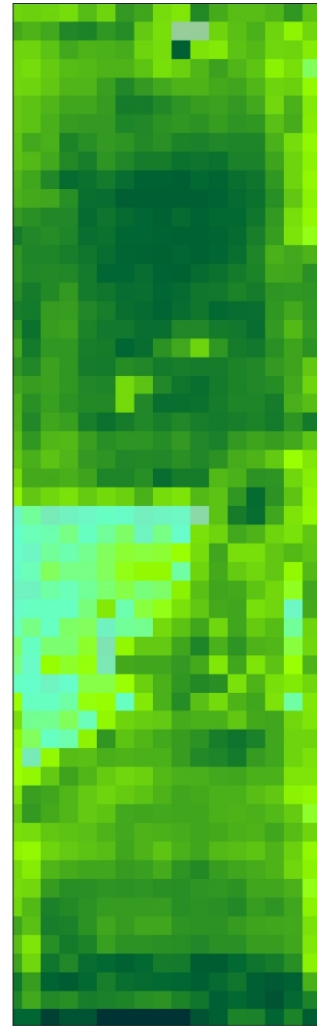
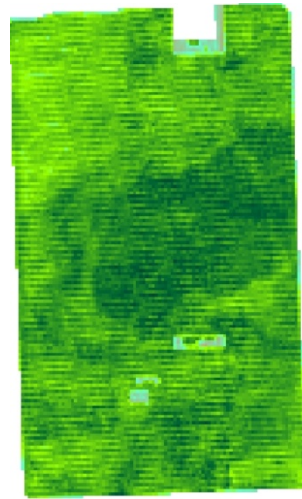
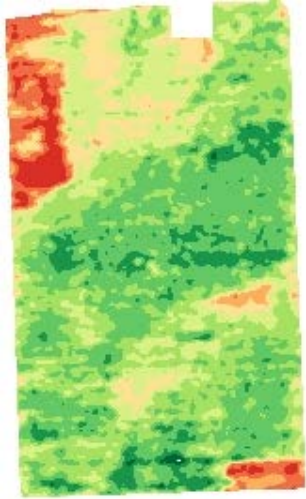
TWITCHELL ISLAND

2013 Yield

Aircraft ET (5m)

Landsat 8 ET (30m)

Yield (tons/ha)



June 12, 2013

Cumulative

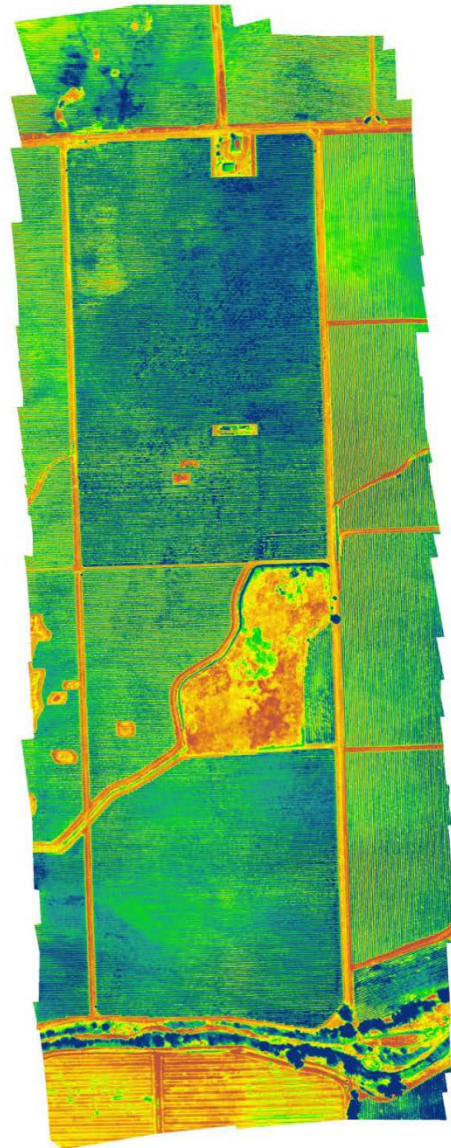
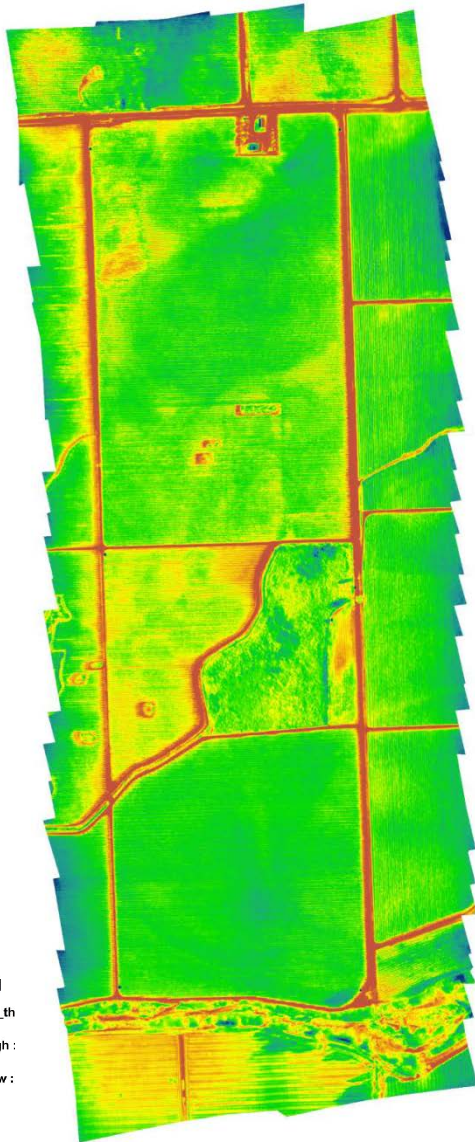
UAV LST - 0.6 m (August 9, 2014)

7 AM

11 AM

Time difference

Legend
D221_PM_th
Value High :
Low :



Legend
D221_thermal_PM-AM II
<VALUE>
-8.8 - 0
0 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
20 - 22
22 - 24
24 - 26
26 - 28
28 - 30
30 - 32
32 - 34
34 - 36
36 - 54.4