ECOSTRESS – Landsat synergy for mapping ET over agricultural landscapes

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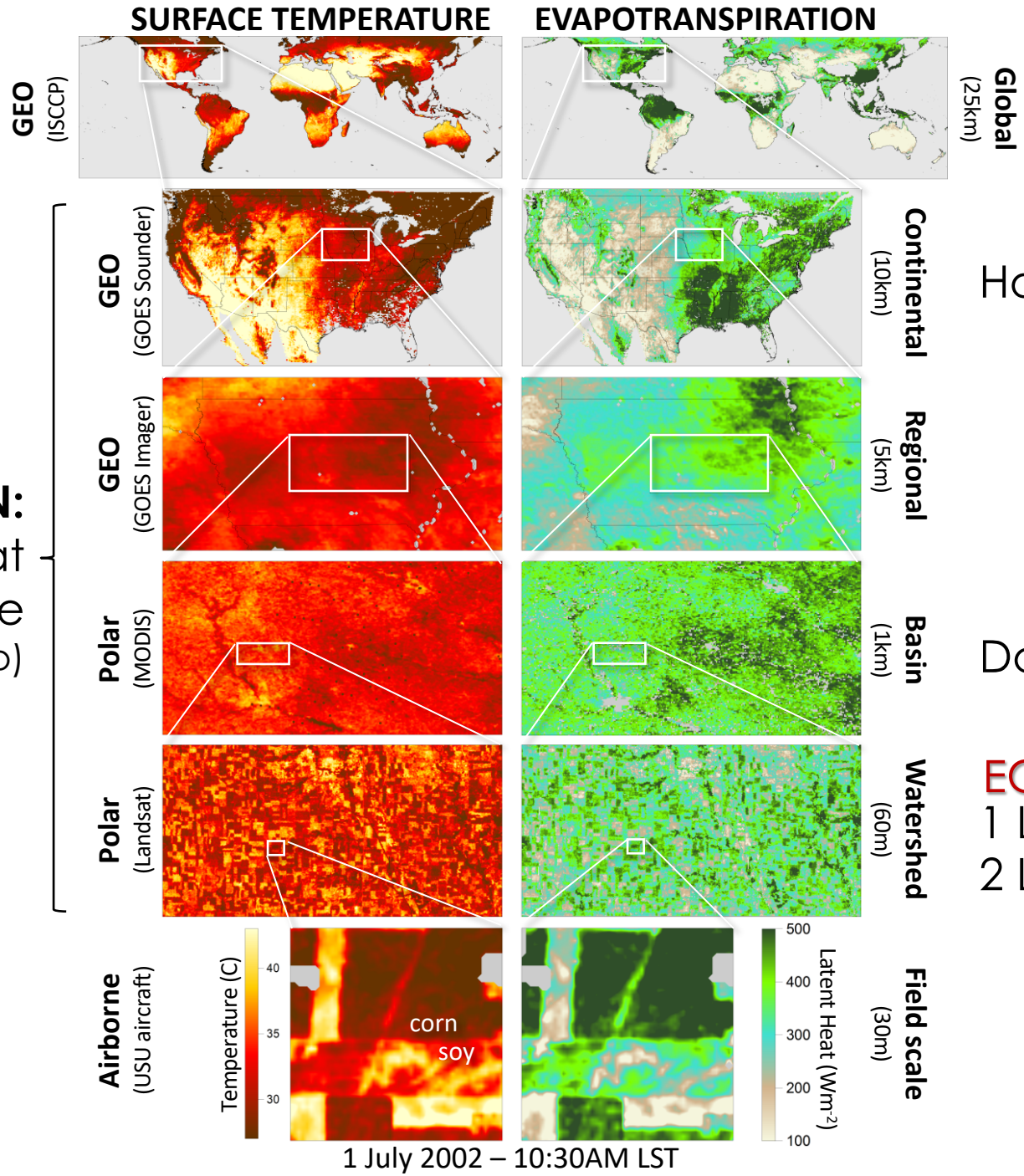
Beltsville, MD

Chris Hain

NASA - MSFC



1 July 2002 – 10:30AM LST

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

Hourly

Daily

ECO – 4 day
1 LS – 16 day
2 LS – 8 day

Landsat 8

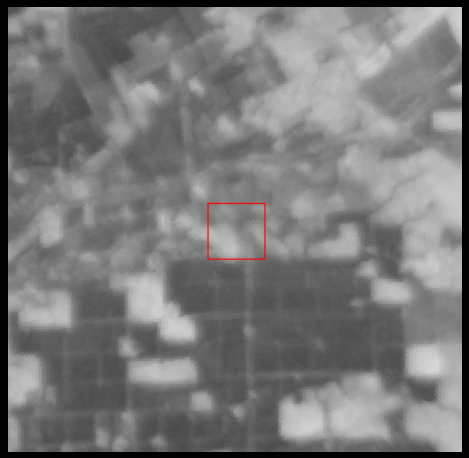
Launch 2/11/2013

Polar Orbit (16 day)
Consistent overpass (~10:30LT)
2 TIR bands (100 m)
VSWIR from Landsat (30 m)

ECOSTRESS

Launch 6/29/2018

ISS Orbit (~4 day)
Variable overpass (here 7-17LT)
5 TIR bands (38x69 m)
VSWIR from closest Landsat (30 m)



PRIMARY SURFACE ENERGY BALANCE RS INPUTS

TIR: LST to constrain fluxes
VSWIR: Surface reflectances to define LAI, Albedo

Landsat 8

Launch 2/11/2013

Polar Orbit (16 day)
Consistent overpass (~10:30LT)
2 TIR bands (100 m)
VNIR from Landsat (30 m)

ECOSTRESS

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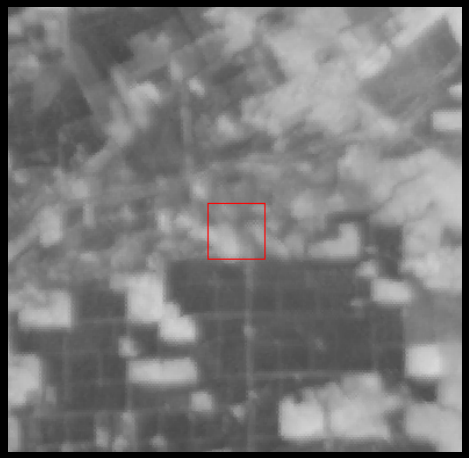
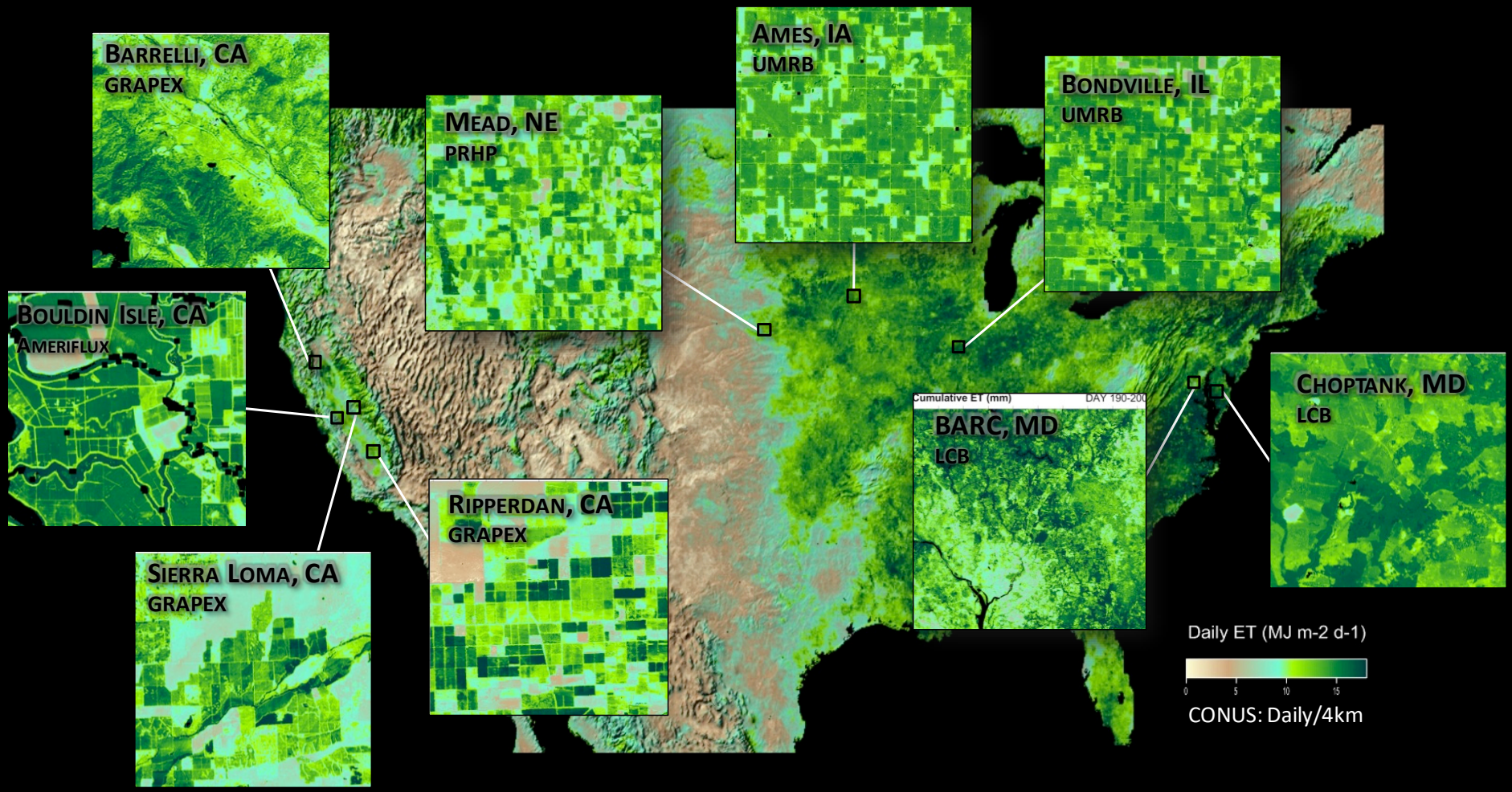


INVESTIGATE IMPACTS OF

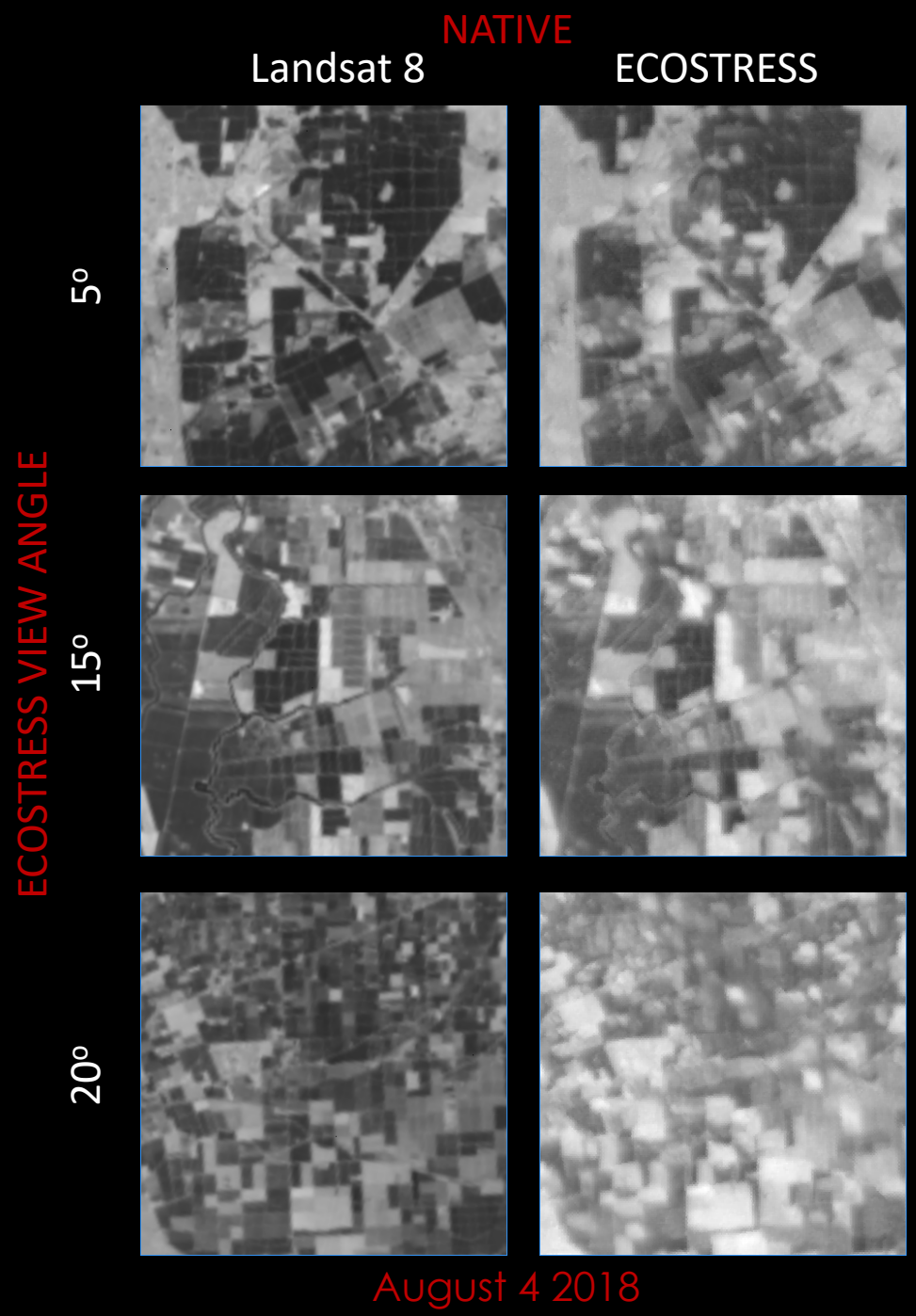
1. View angle
2. Overpass time
3. Overpass frequency
4. TIR/VSWIR separation

Landsat – ECOSTRESS Evaluation Sites



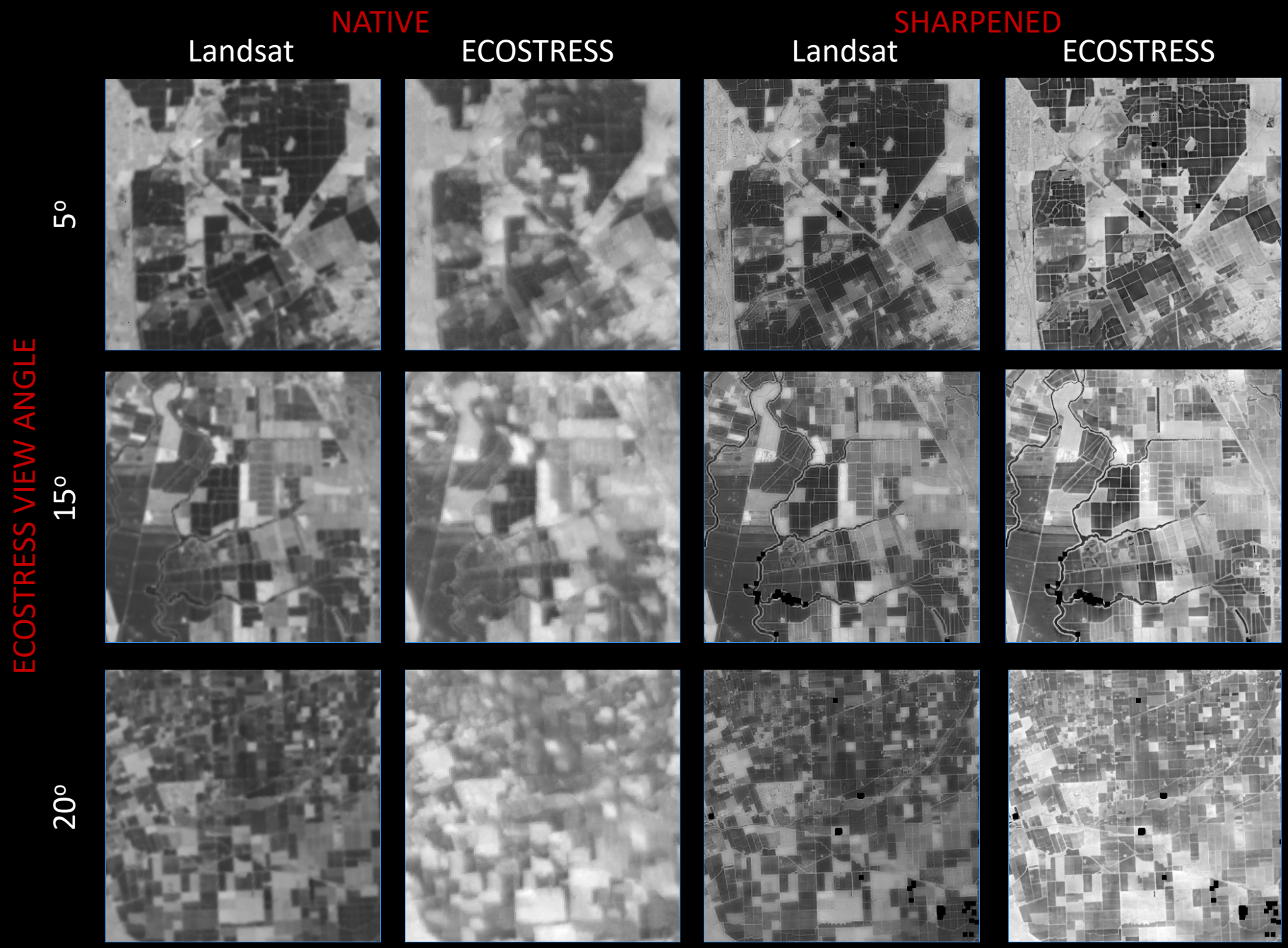
USDA-ARS Long-Term Agroecosystem Research (LTAR) Sites

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

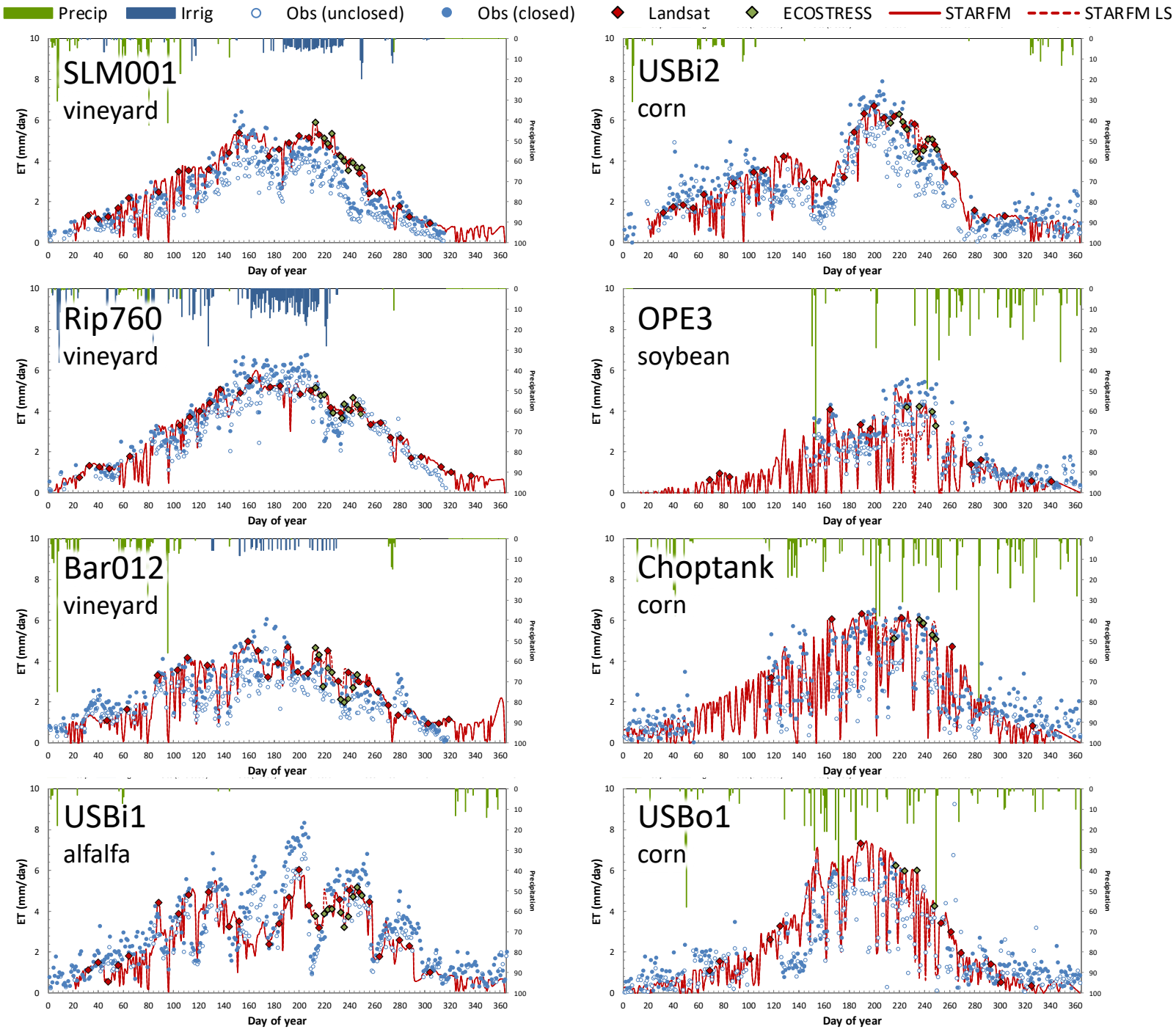


Comparison of Landsat 8 and ECOSTRESS LST

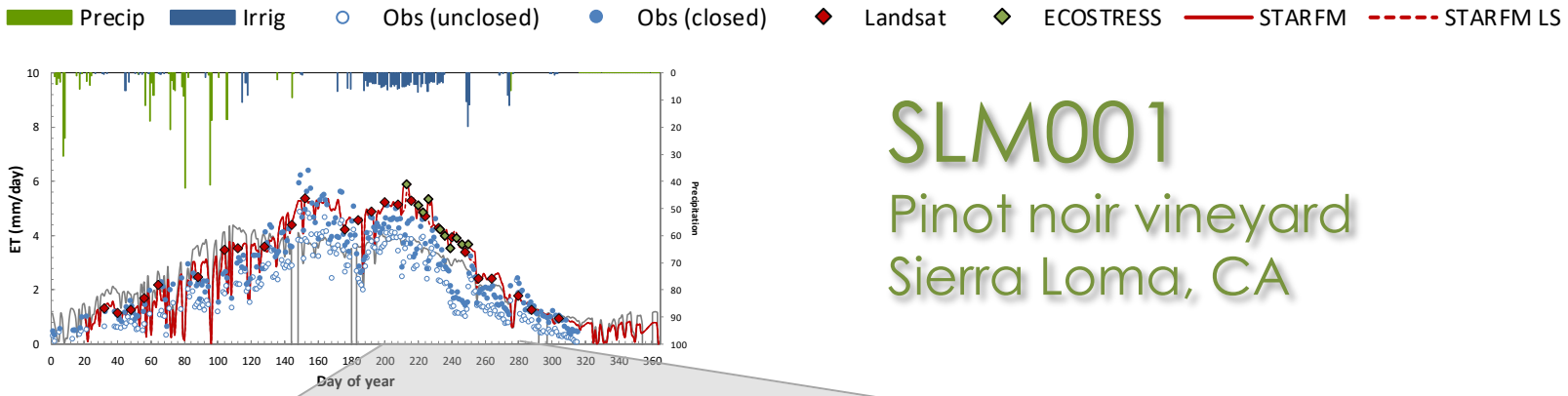
- L2 ECOSTRESS LST product has somewhat lower resolution than L8 at nadir
- Effective resolution tends to coarsen with view angle



Data Mining Sharpener (Gao et al. 2012)

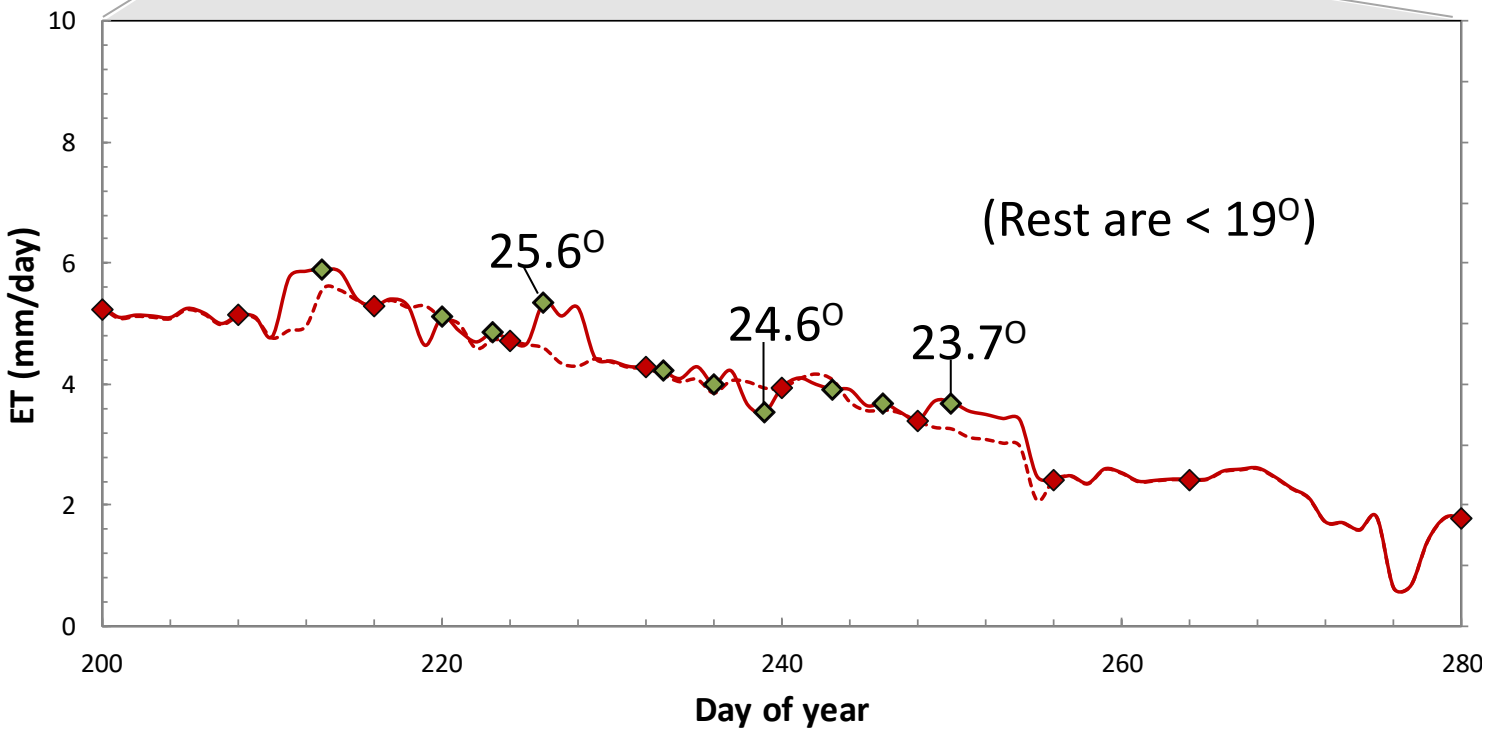

Precip
Irrig
Obs (unclosed)
Obs (closed)
Landsat
ECOSTRESS
STARFM
STARFM LS
SLM001
vineyard
USBi2
corn
Rip760
vineyard
OPE3
soybean
Bar012
vineyard
Choptank
corn
USBi1
alfalfa
USBo1
corn
ET (mm/day)
Precipitation
Day of year

Impacts of ECOSTRESS view angle

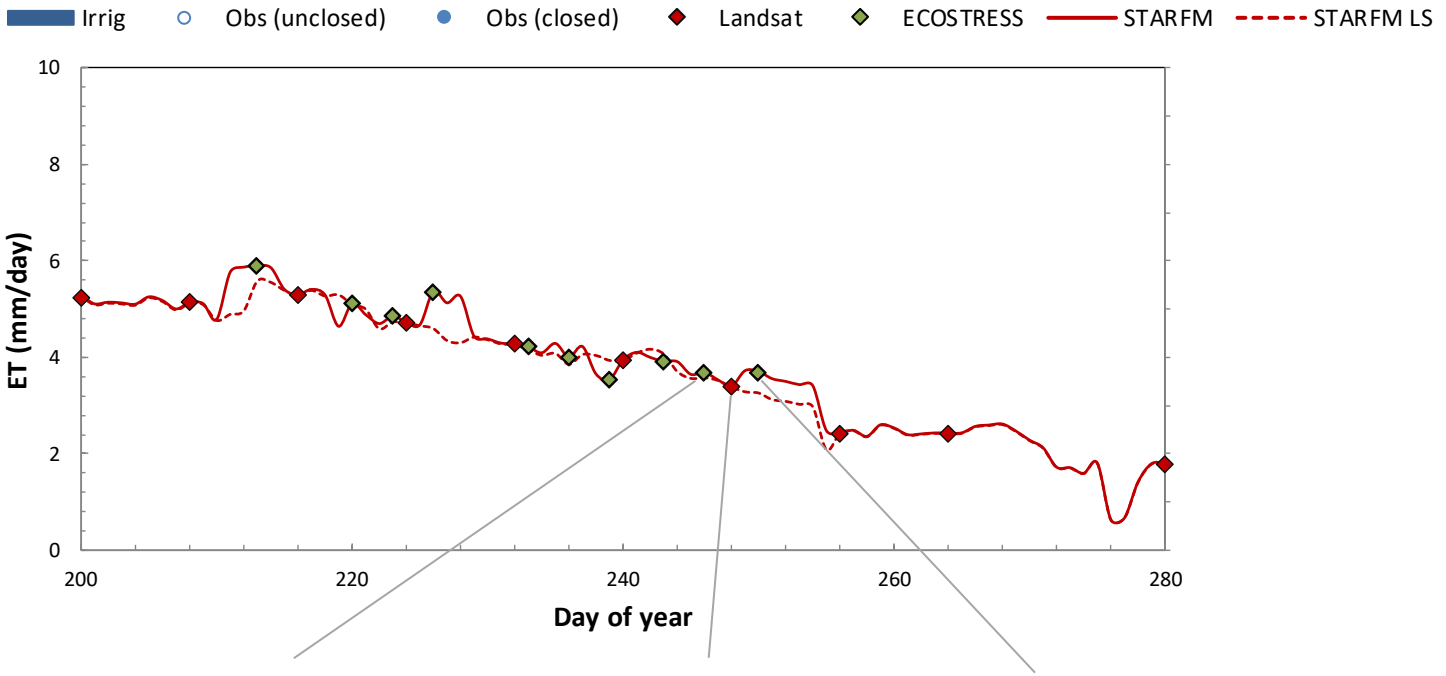


SLM001

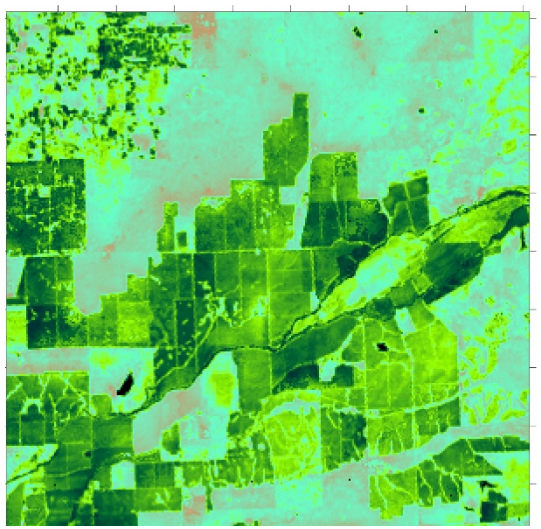
Pinot noir vineyard
Sierra Loma, CA



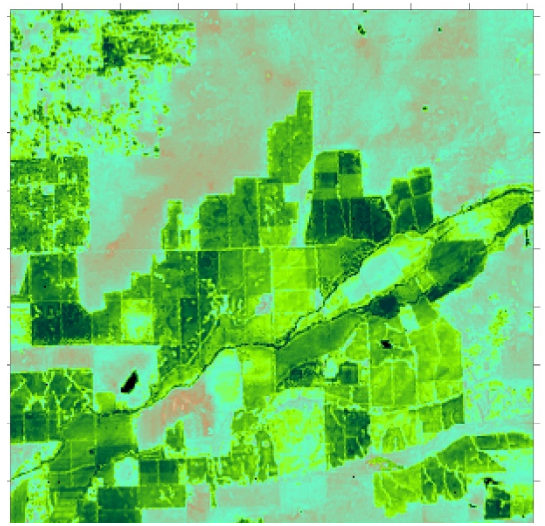
Impacts of ECOSTRESS view angle



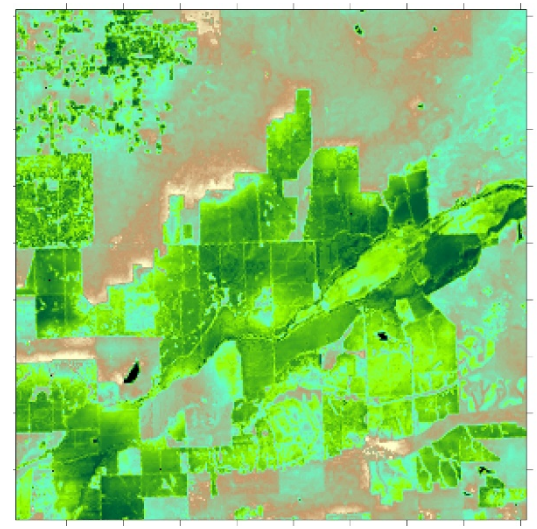
246 ECOSTRESS 11.6°



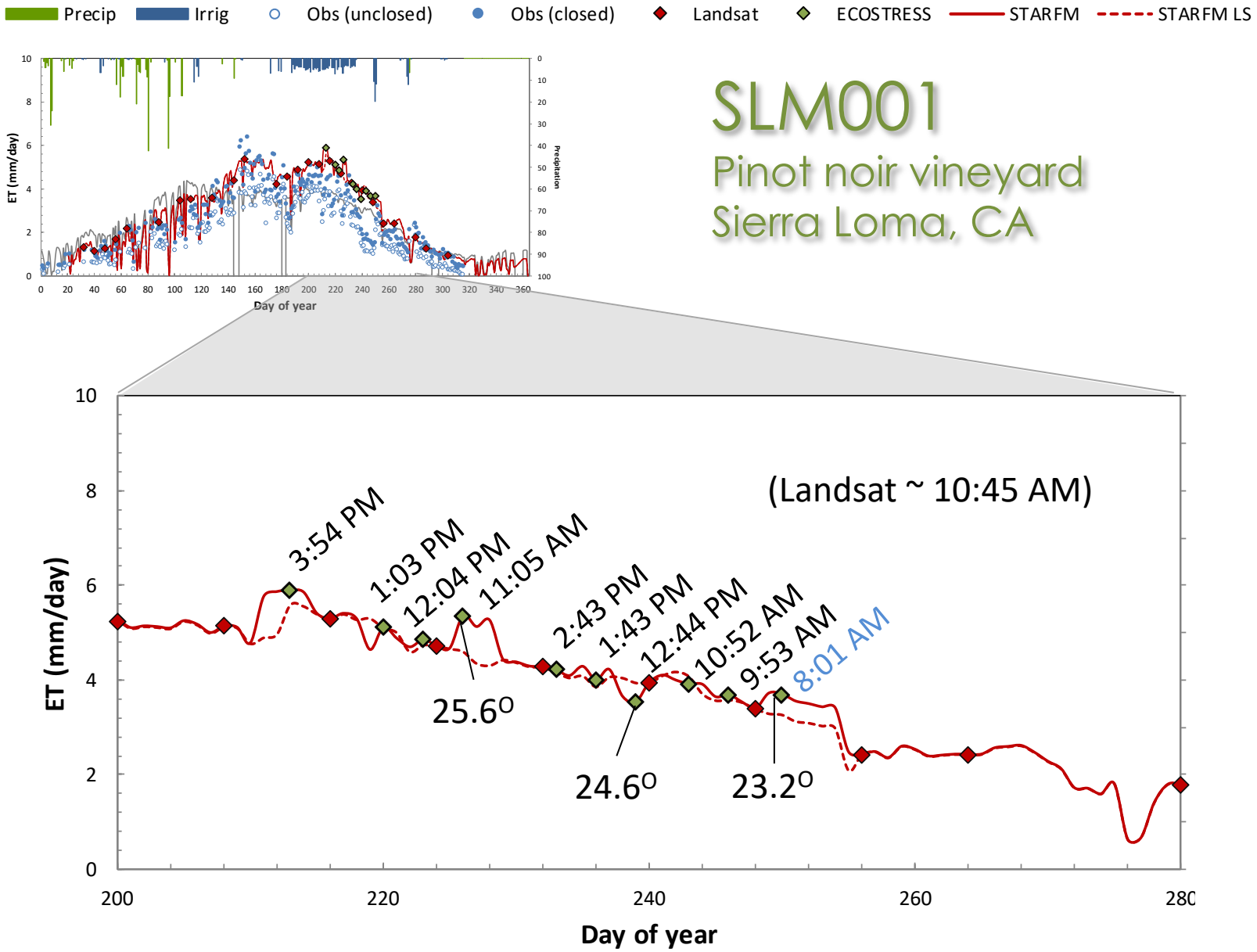
248 Landsat 8 <7°



250 ECOSTRESS 23.7°

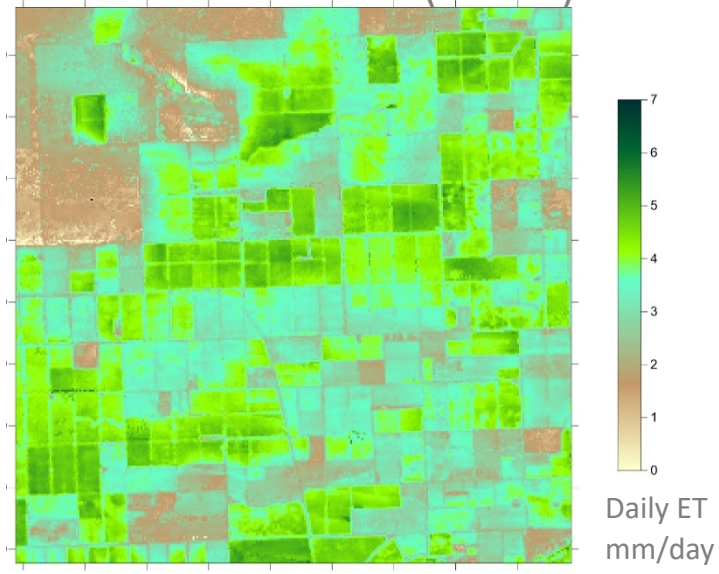


Impact of ECOSTRESS overpass time

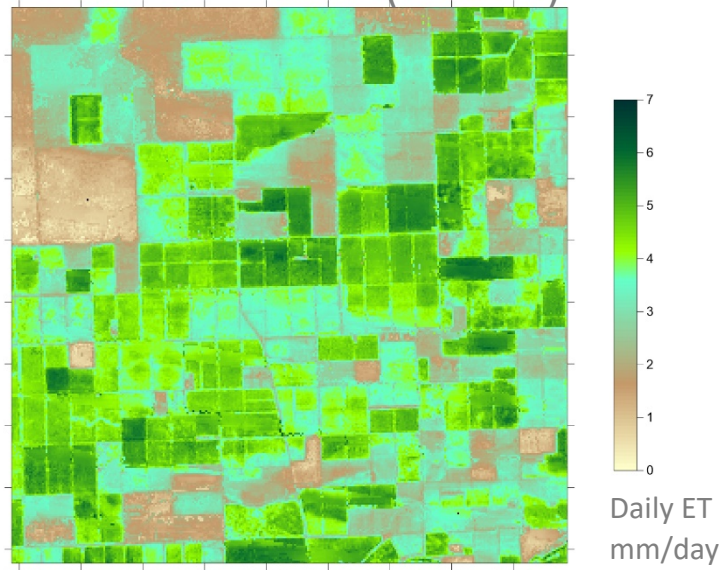


Impact of ECOSTRESS overpass time

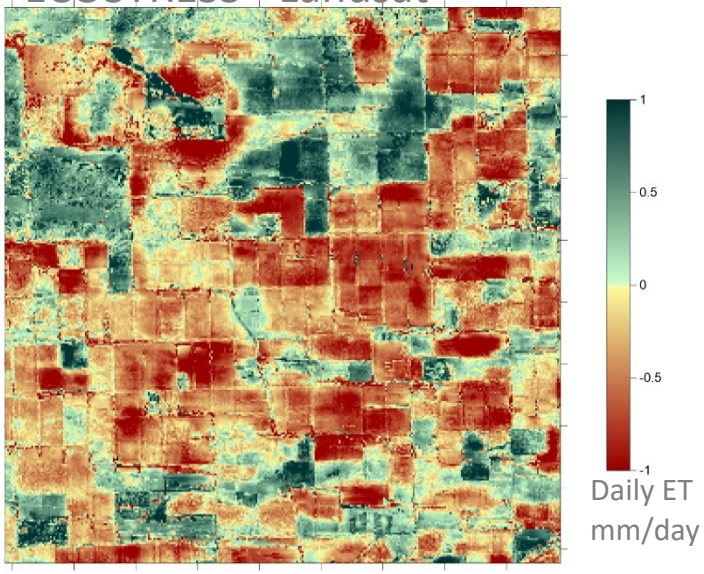
ECOSTRESS 23.9^{o} (845 LT)



Landsat (1038 LT)

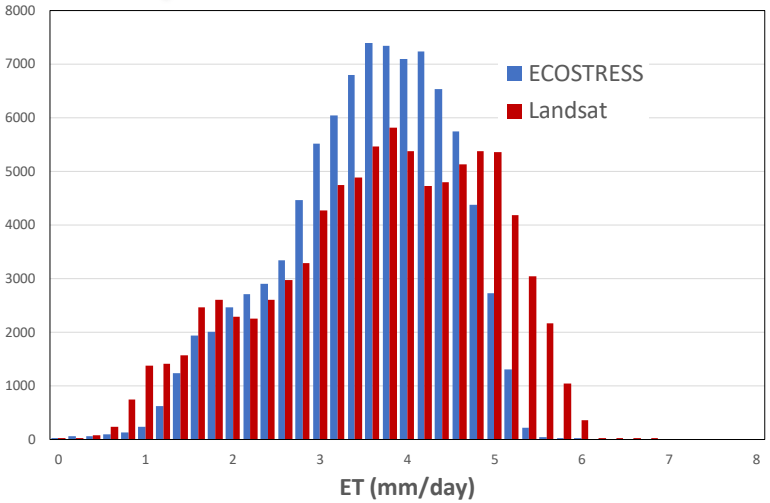


ECOSTRESS - Landsat

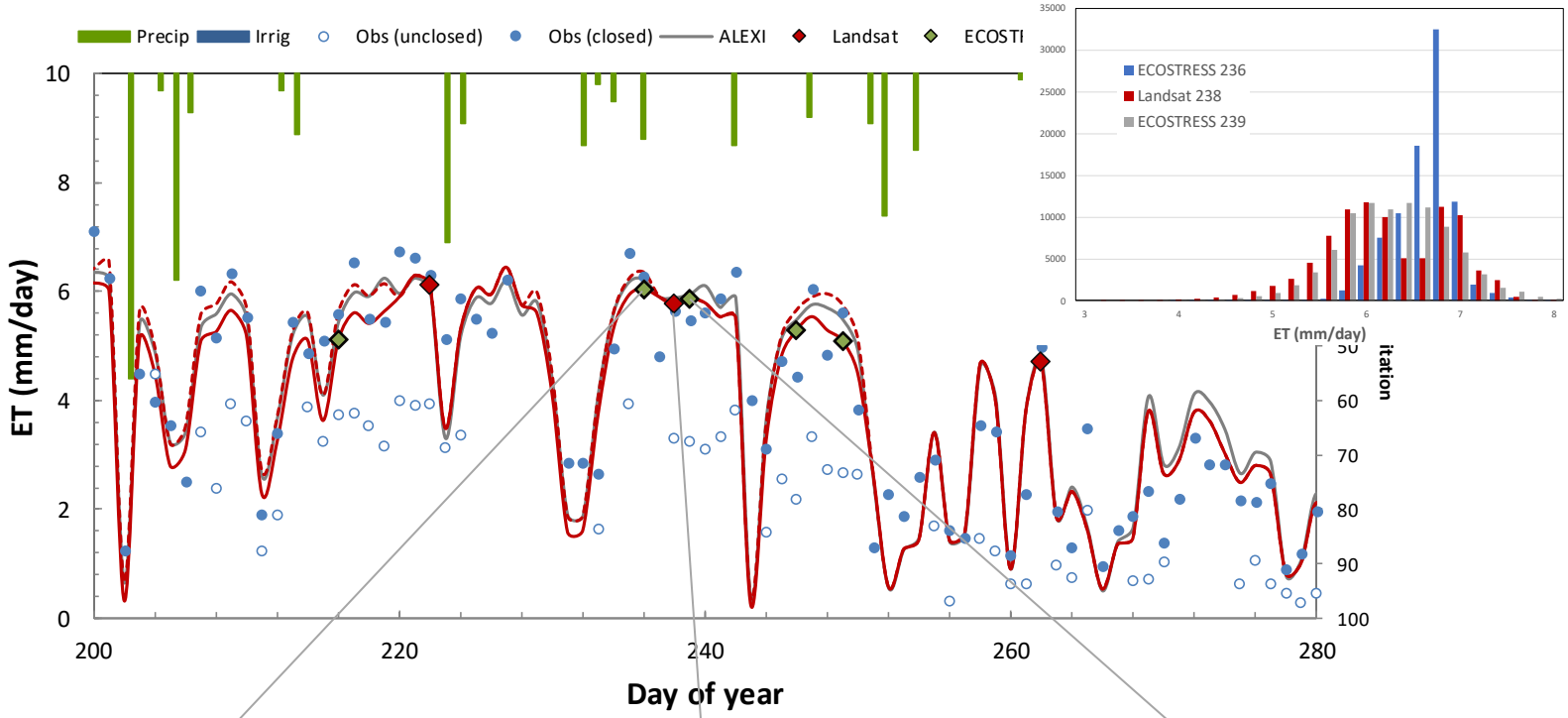


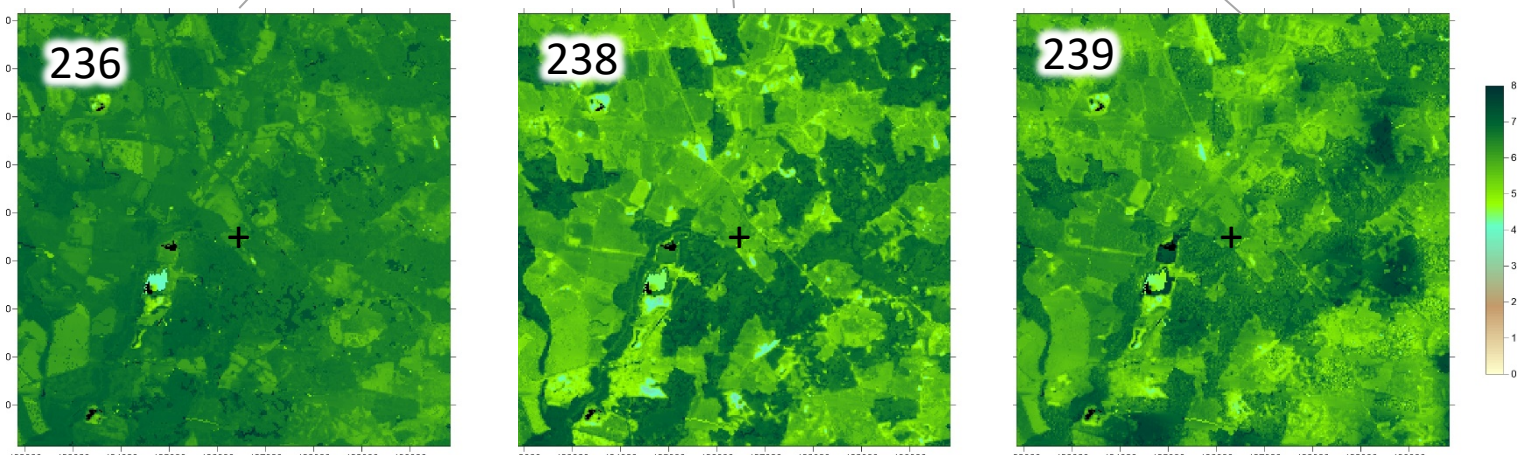
Ripperdan

6 September 2018



Impact of ECOSTRESS overpass time

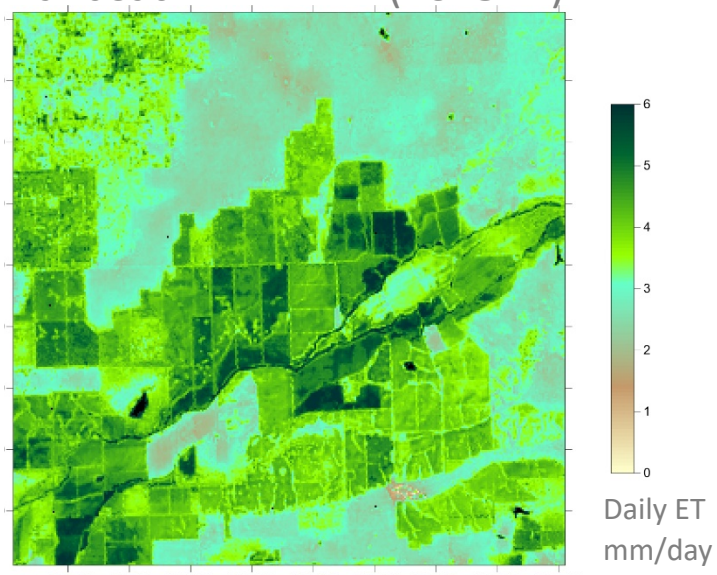




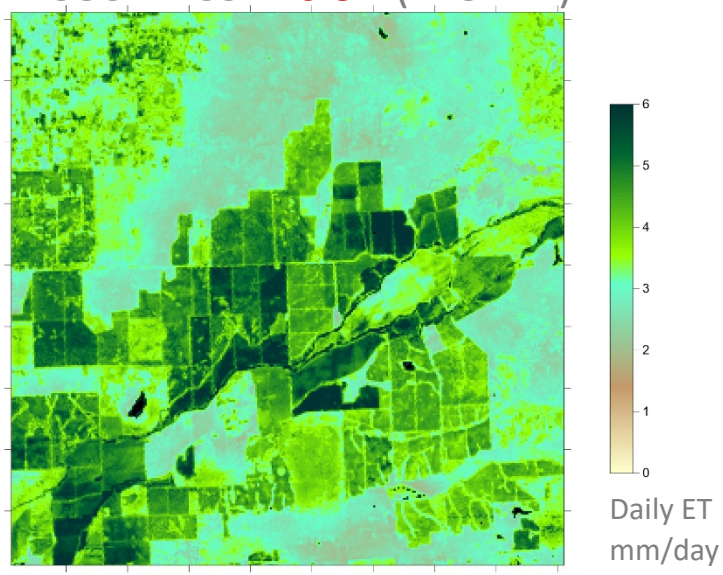
ECO 11.0° (709 LT) L7 (1038 LT) ECO 19.5° (1239 LT)

Impact of ECOSTRESS overpass time

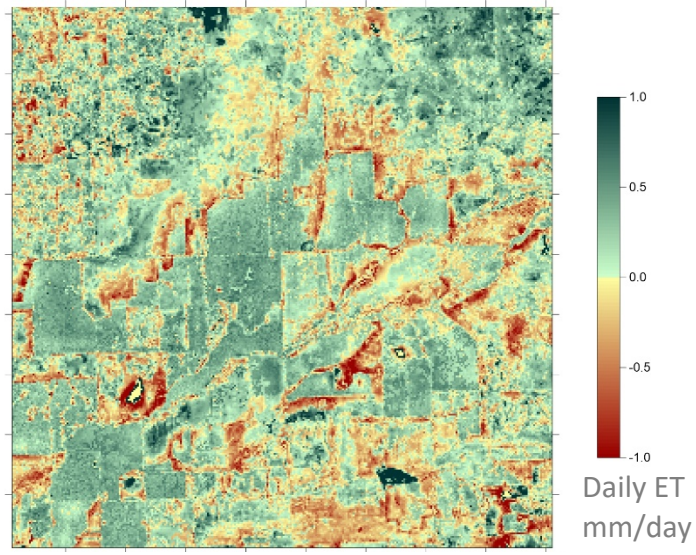
Landsat (1045 LT)



ECOSTRESS 16.5° (1454 LT)

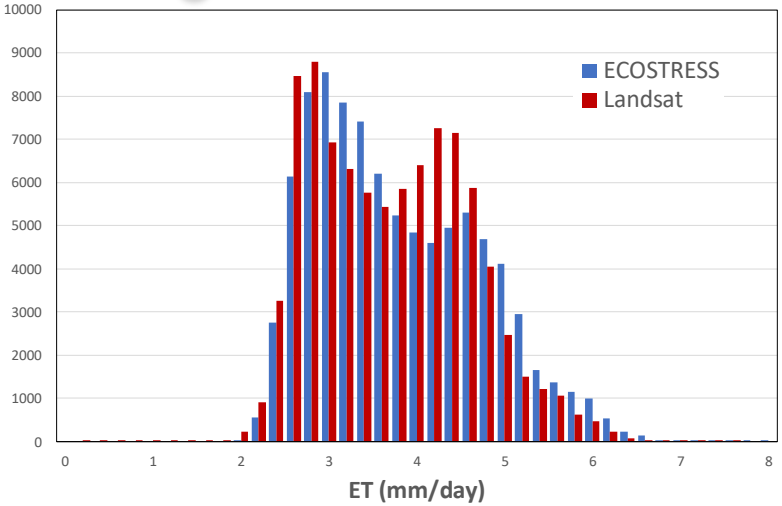


ECOSTRESS - Landsat



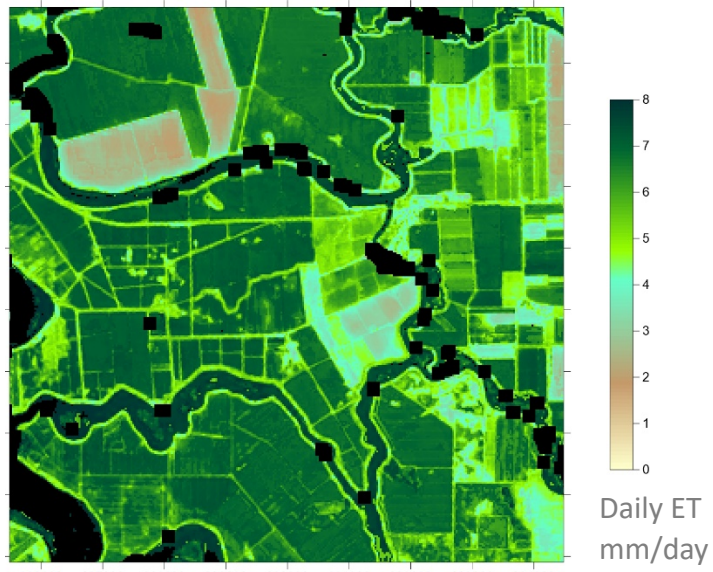
Sierra Loma

4 August 2018

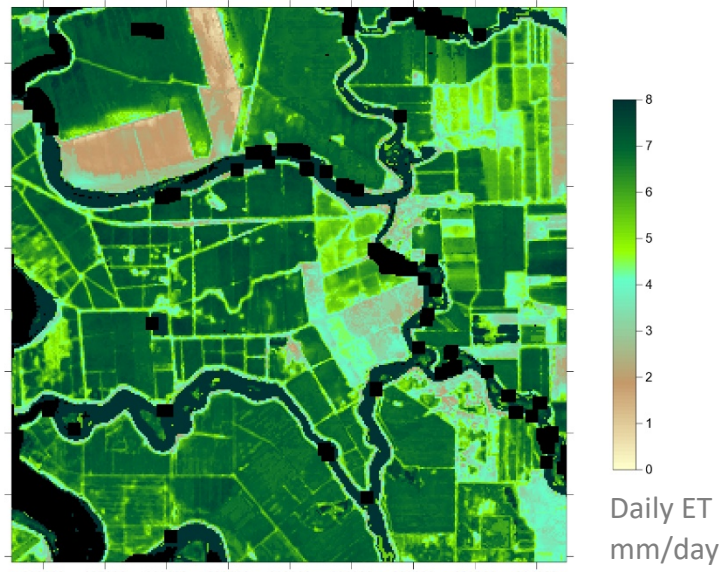


Impact of ECOSTRESS overpass time

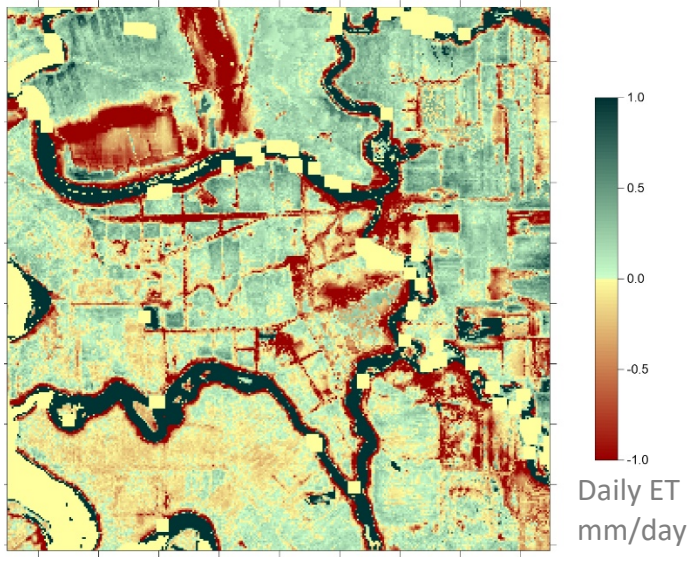
Landsat (1045 LT)



ECOSTRESS 15.7° (1454 LT)

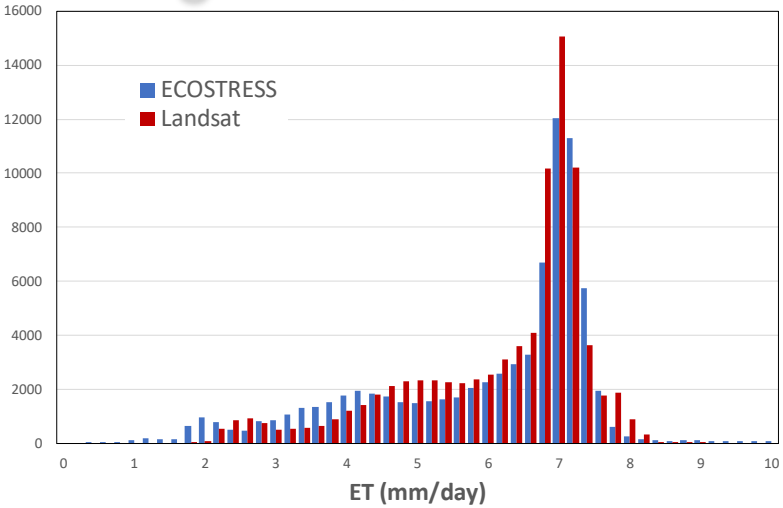


ECOSTRESS - Landsat



Bouldin Island

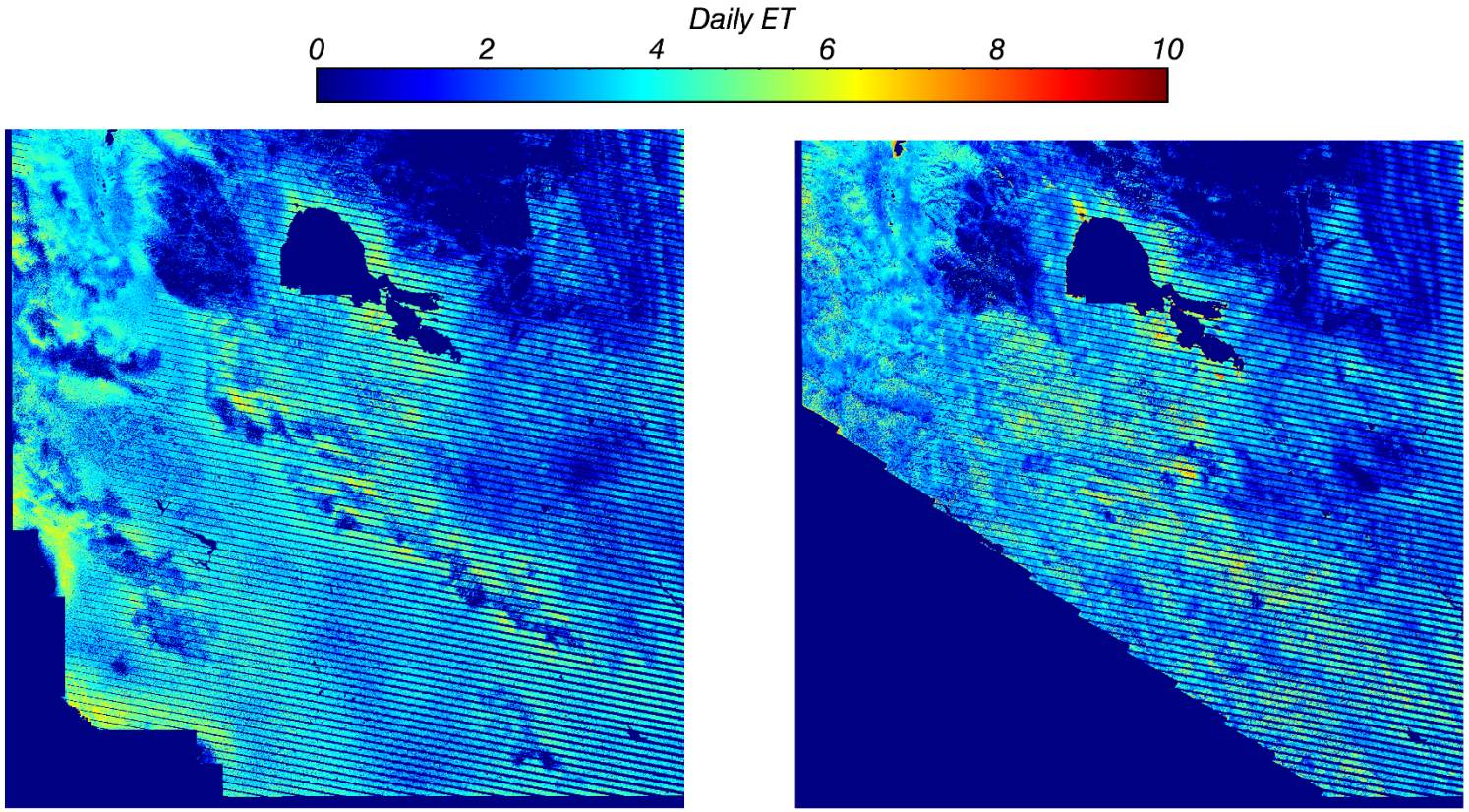
4 August 2018



Impact of ECOSTRESS overpass time

Barrelli Creek - Sonoma, CA

21 August 2018



8:14 AM

2:43 PM

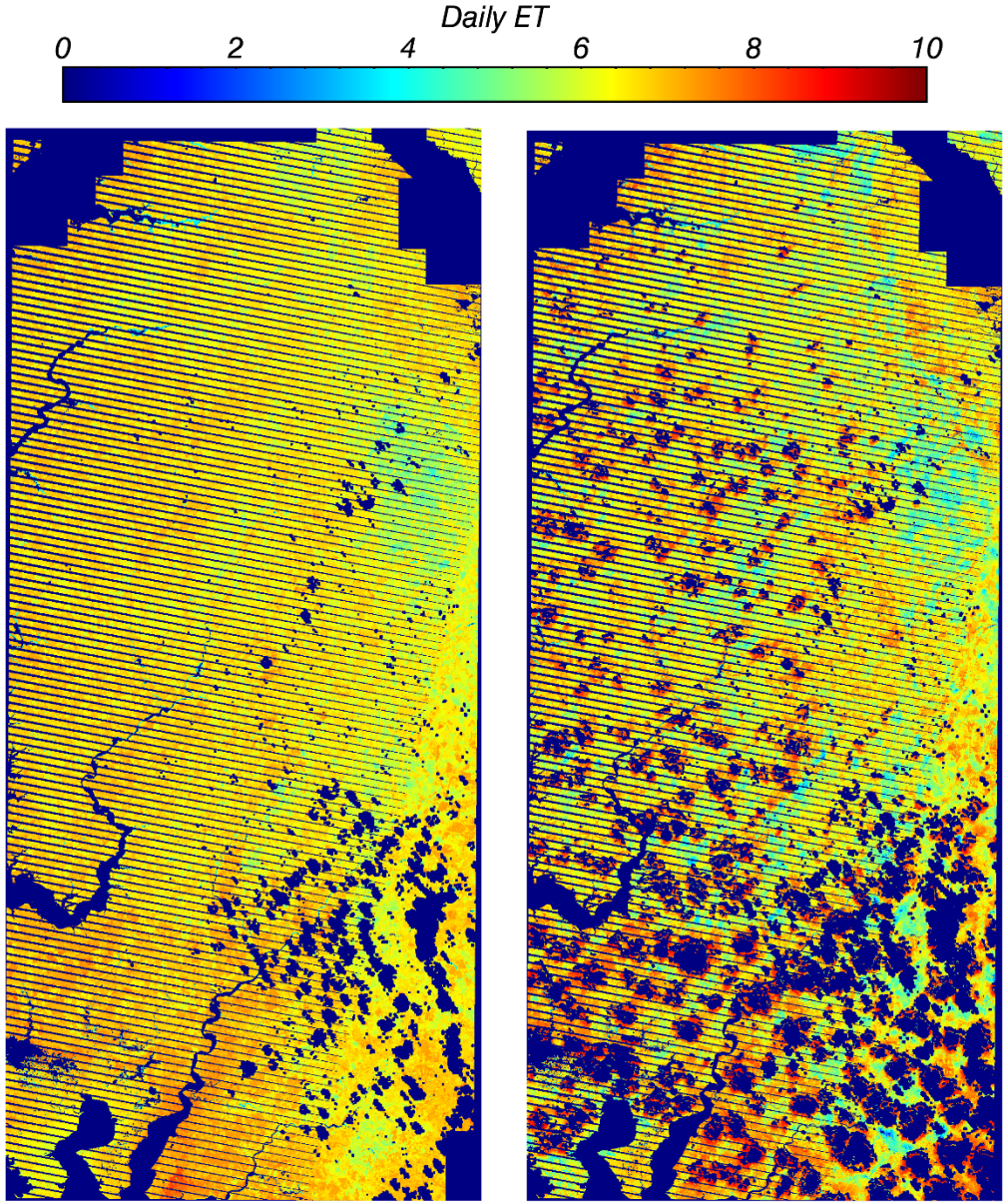
Earlier images in Sonoma tend to be fog-impacted

Impact of ECOSTRESS overpass time

Choptank Eastern Shore MD

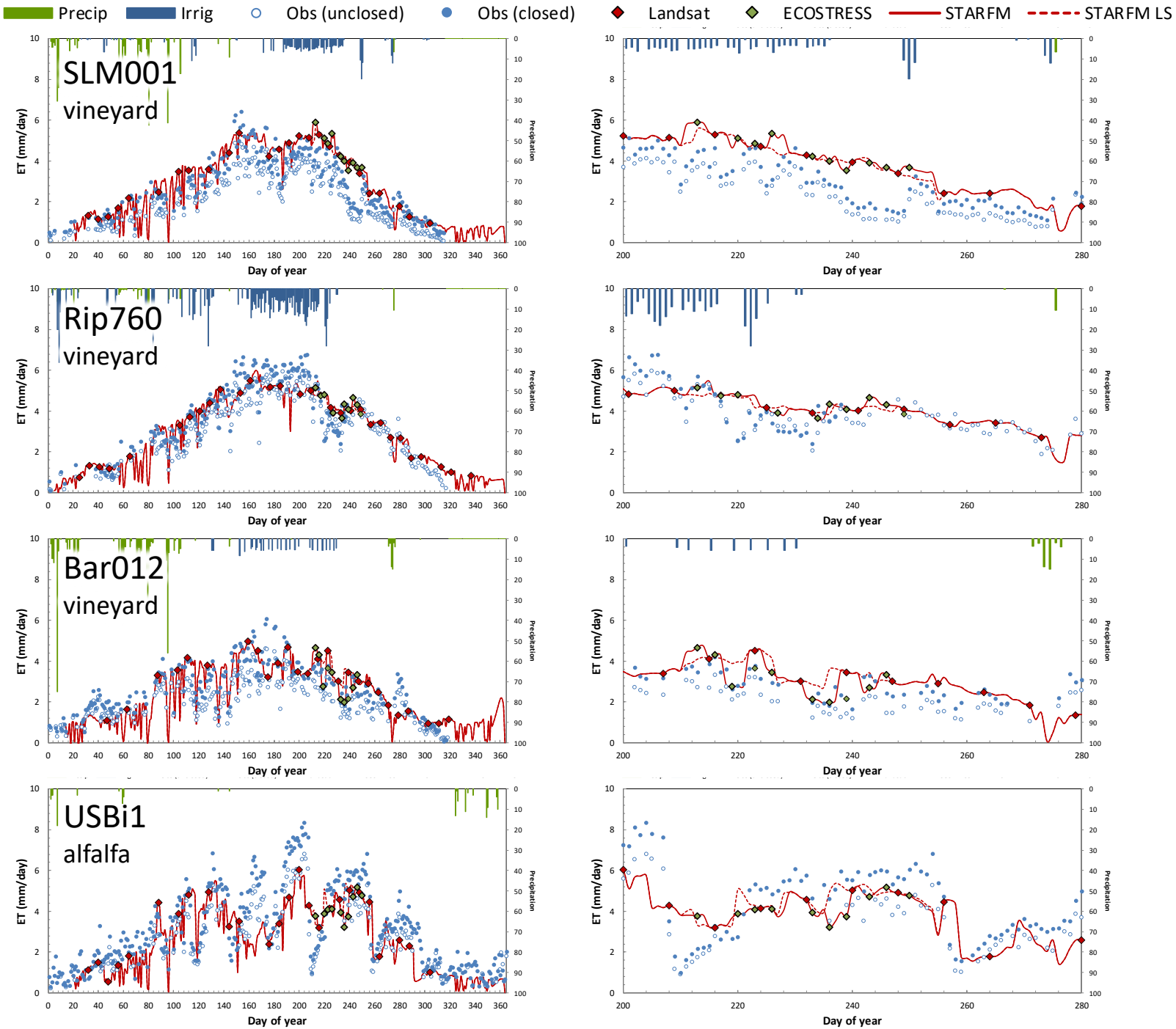
24 August 2018

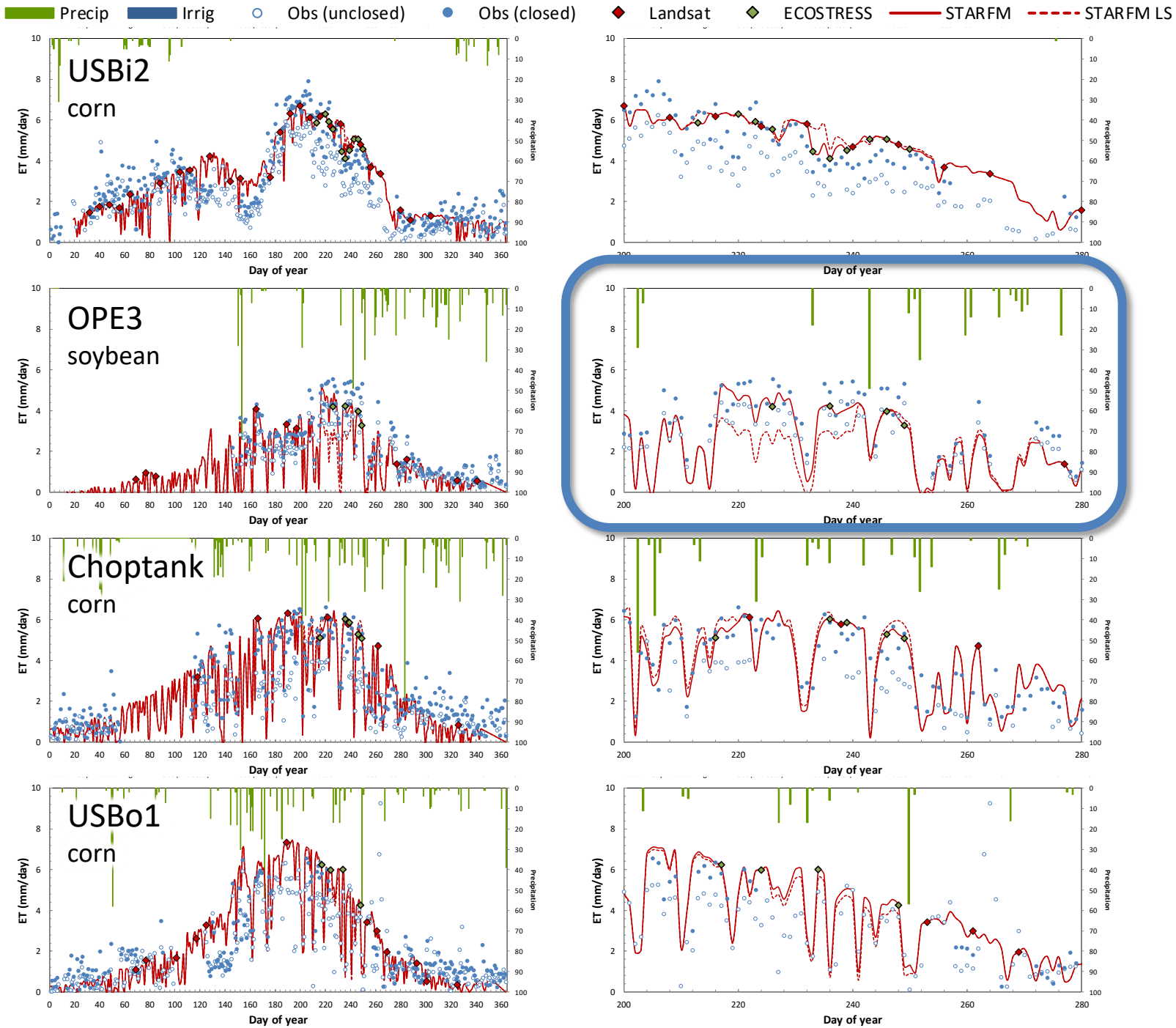
Post-noon images in central and eastern U.S. tend to have more convective cloud cover



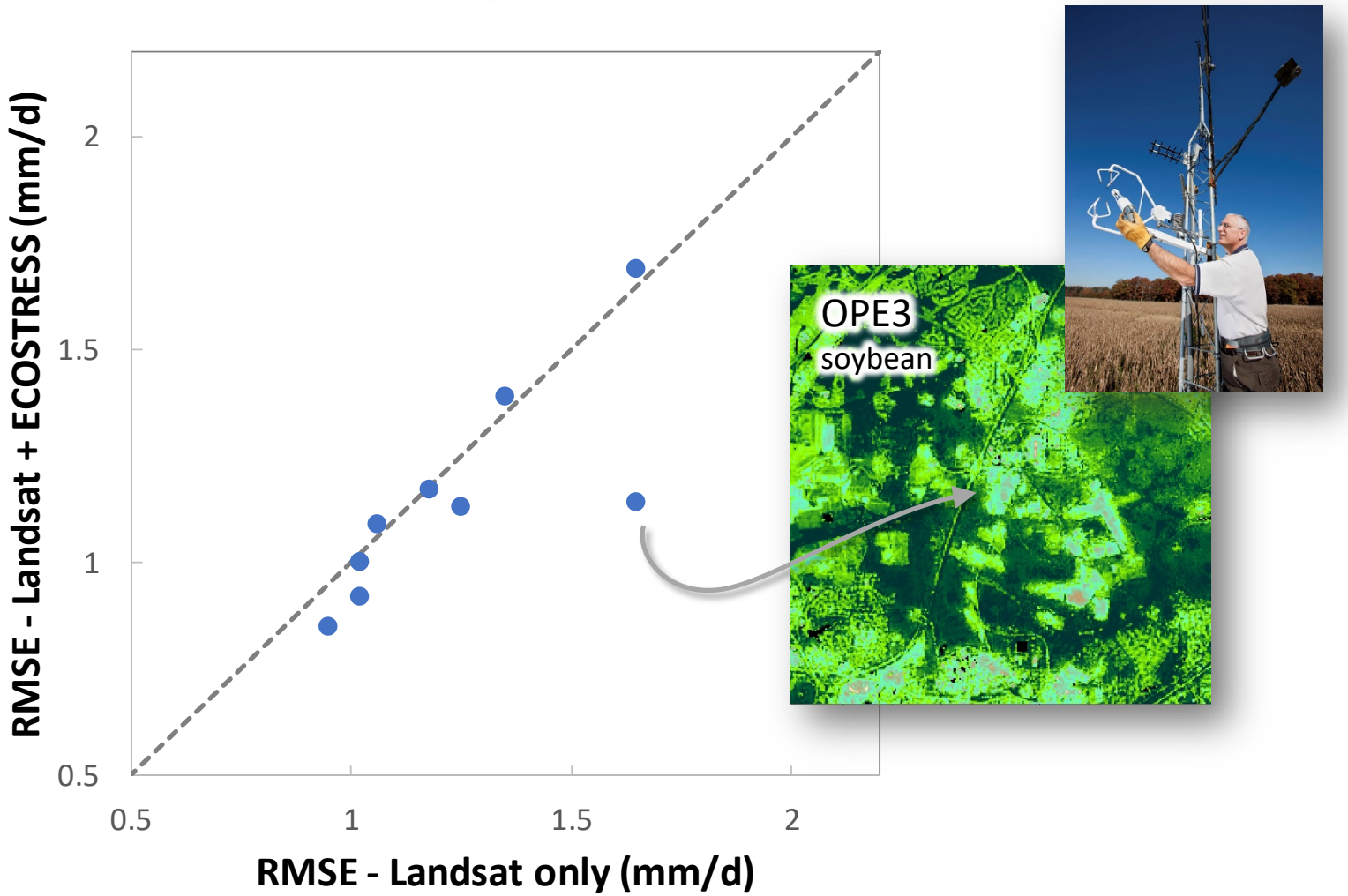
7:09 AM

3:37 PM


Precip
Irrig
Obs (unclosed)
Obs (closed)
Landsat
ECOSTRESS
STARFM
STARFM LS
SLM001
vineyard
Rip760
vineyard
Bar012
vineyard
USBi1
alfalfa
ET (mm/day)
Precipitation
Day of year


Precip
Irrig
Obs (unclosed)
Obs (closed)
Landsat
ECOSTRESS
STARFM
STARFM LS
USBi2
corn
OPE3
soybean
Choptank
corn
USBo1
corn
ET (mm/day)
Precipitation
Day of year

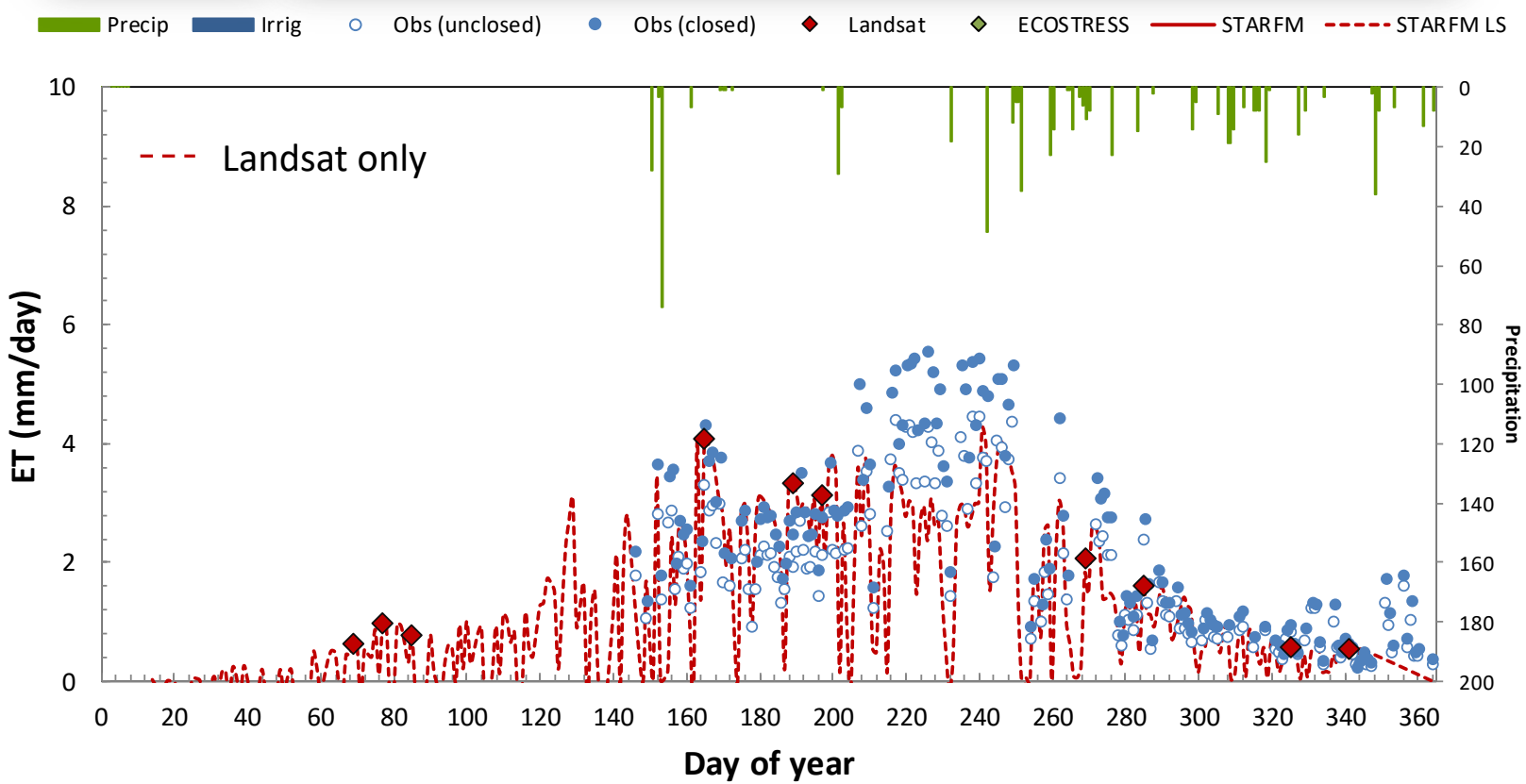
RMSE in Daily ET: DOY 200-280



Impacts of enhanced frequency

OPE3 - soybean

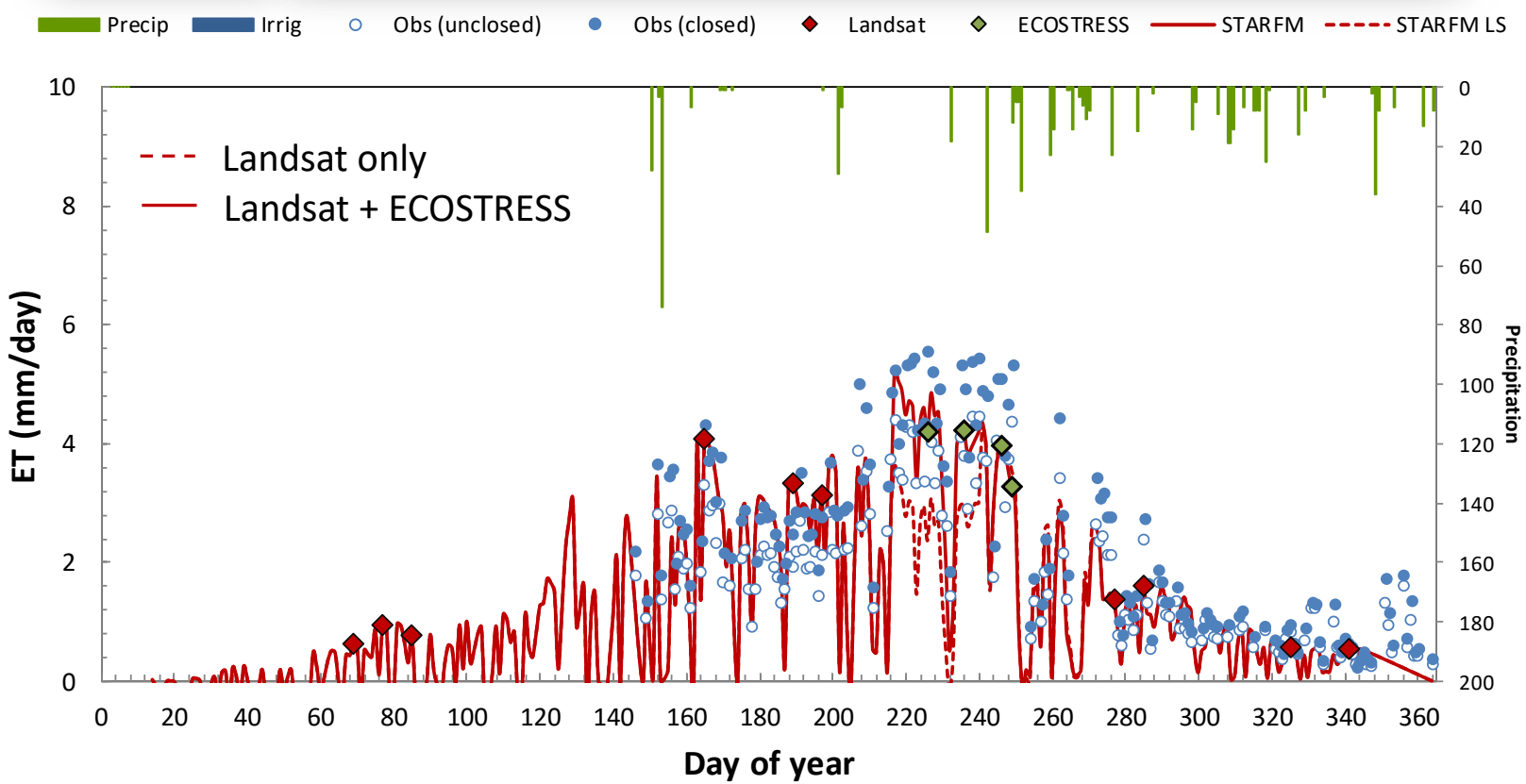
Beltsville Agricultural Research Center



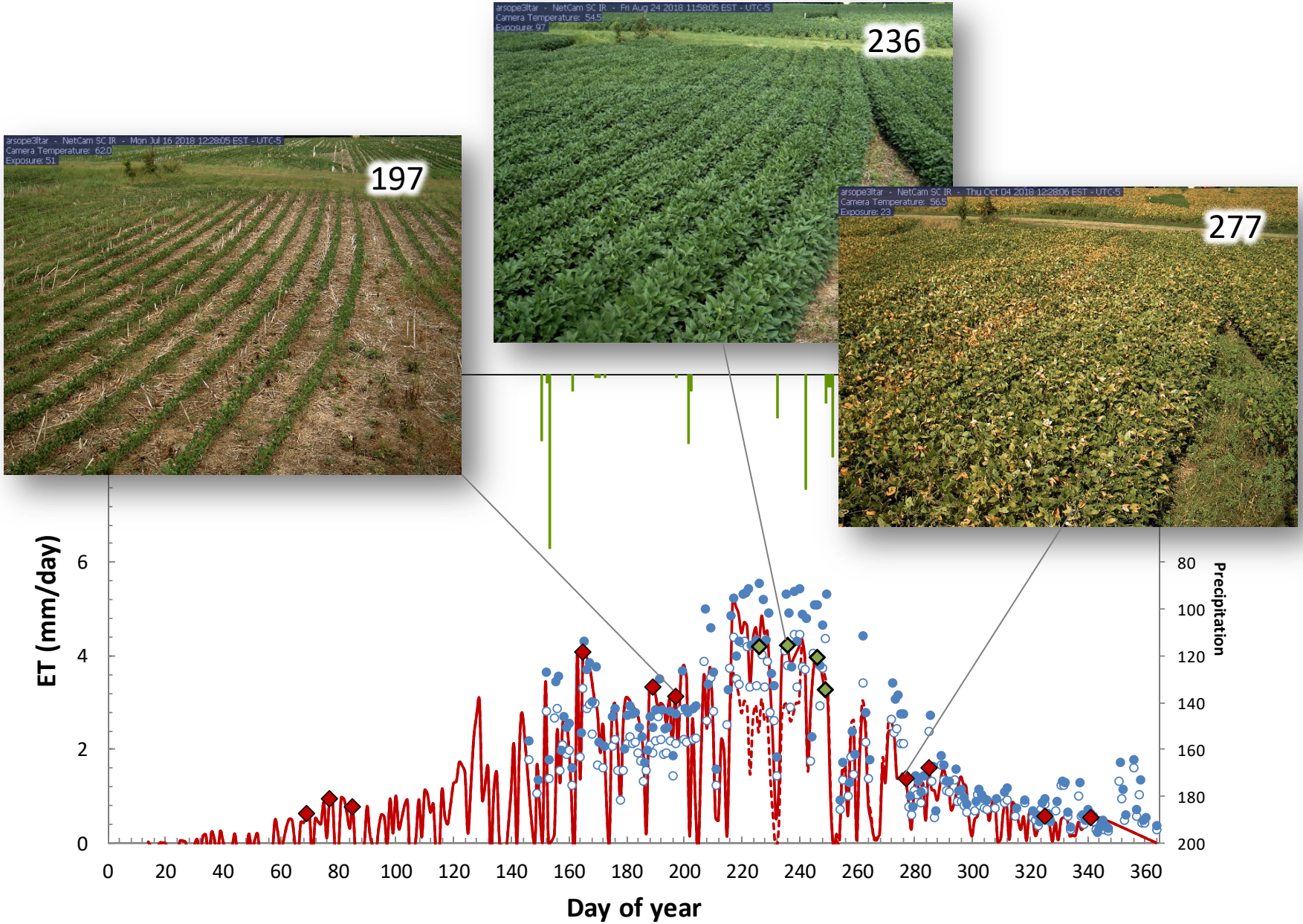
Impacts of enhanced frequency

OPE3 - soybean

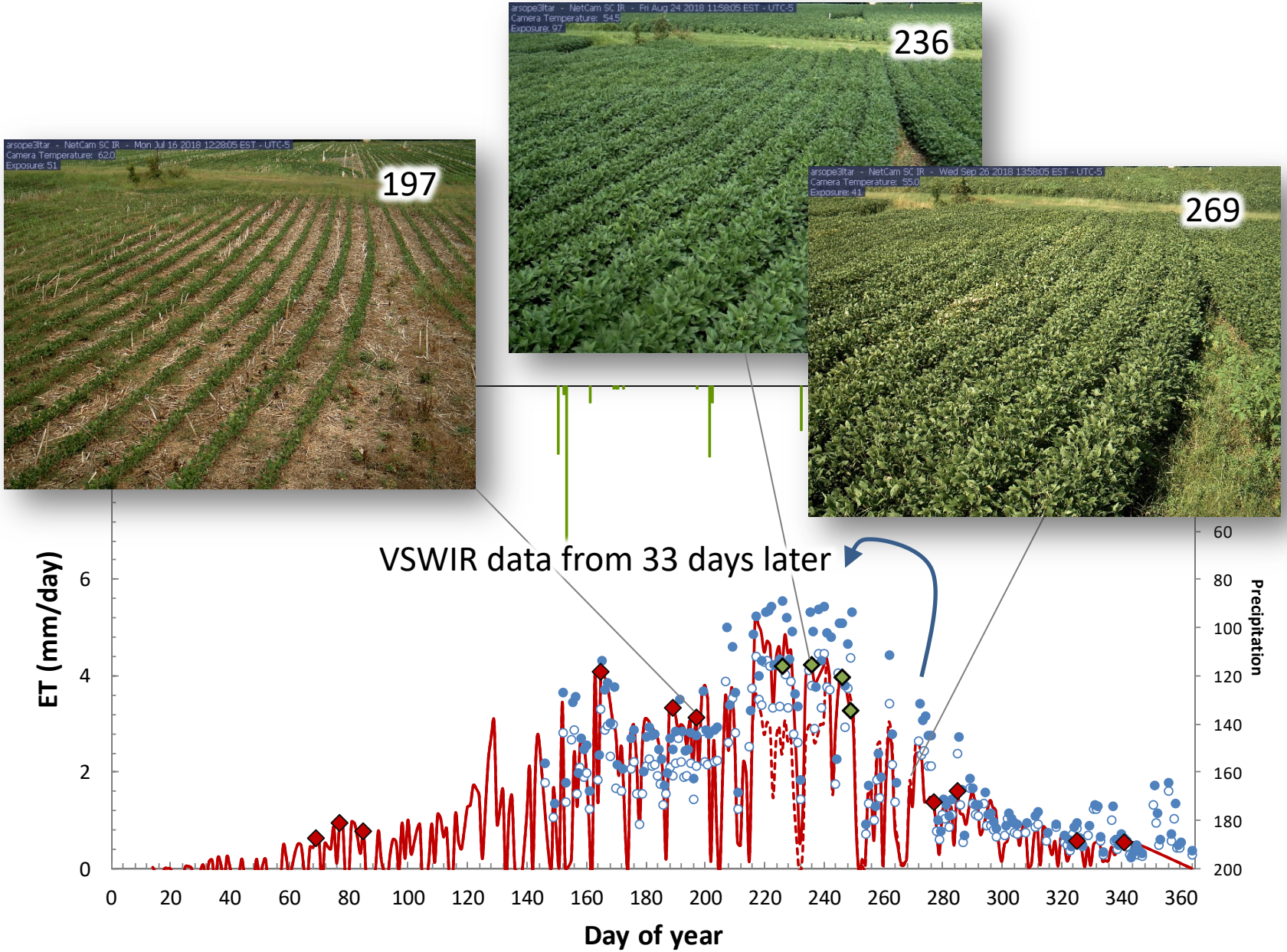
Beltsville Agricultural Research Center



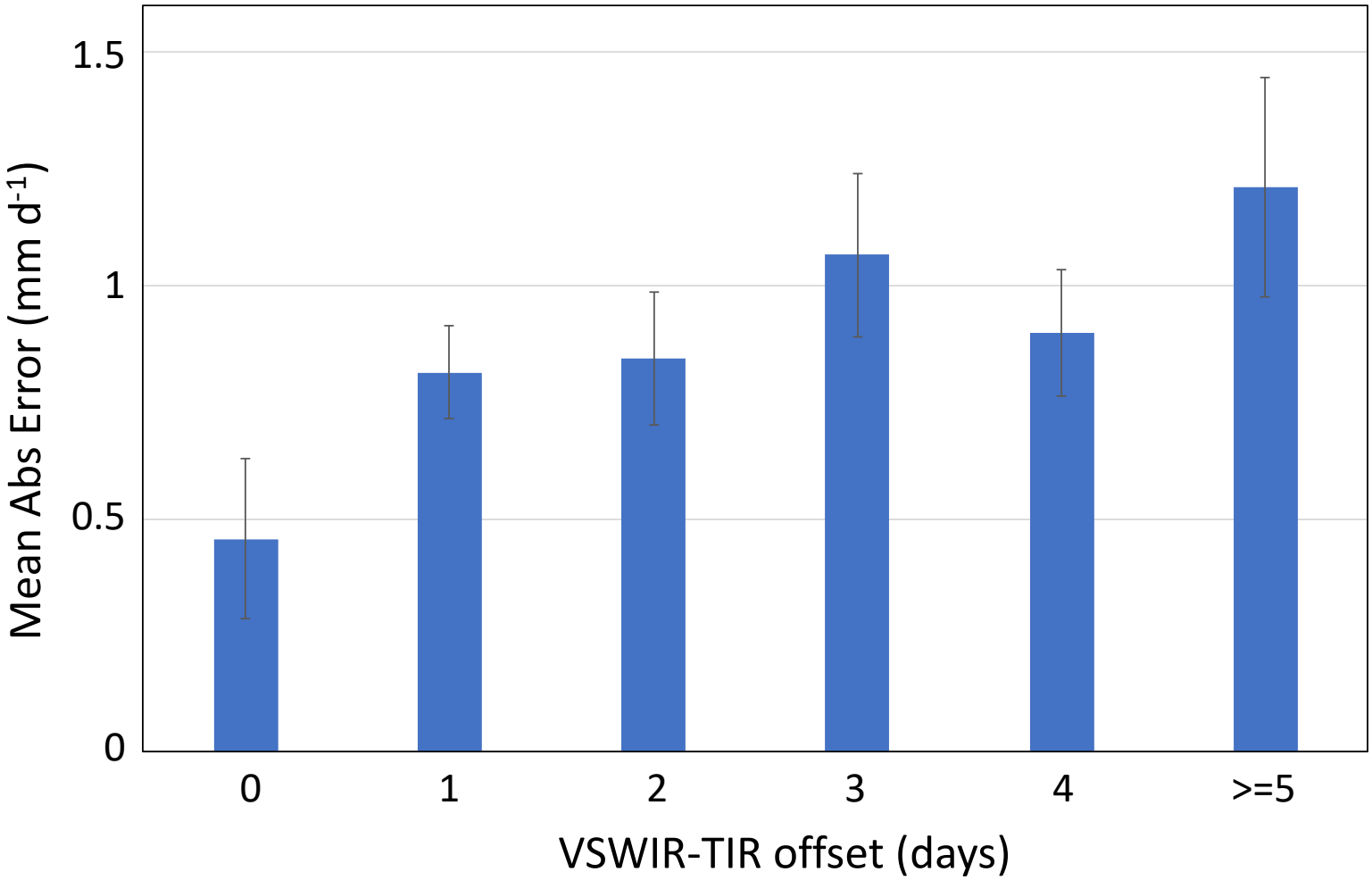
Impacts of enhanced frequency

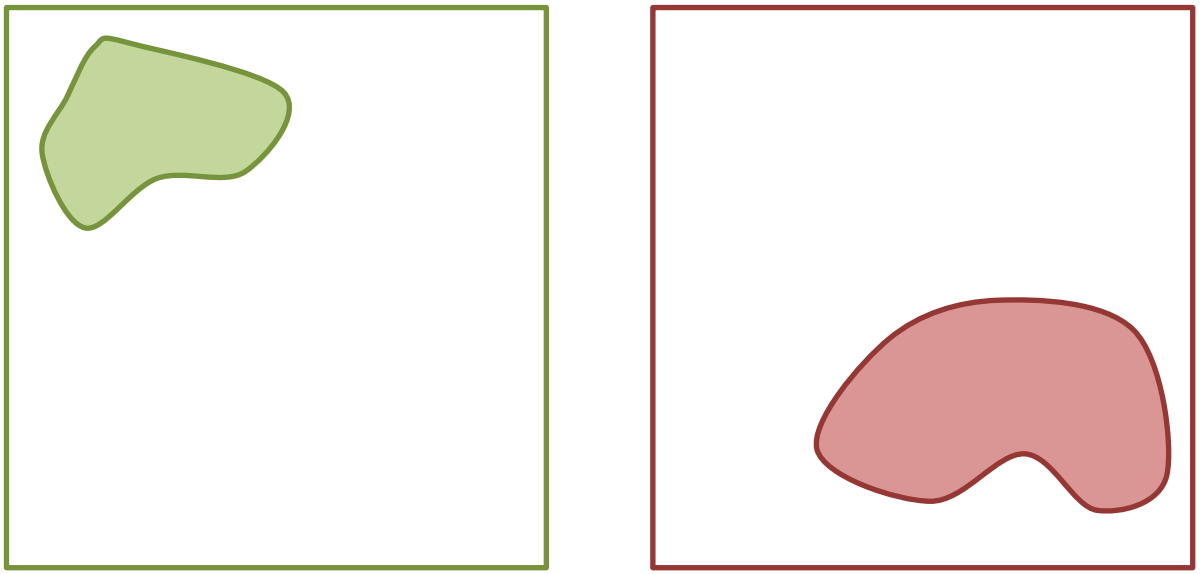


Impacts of enhanced frequency



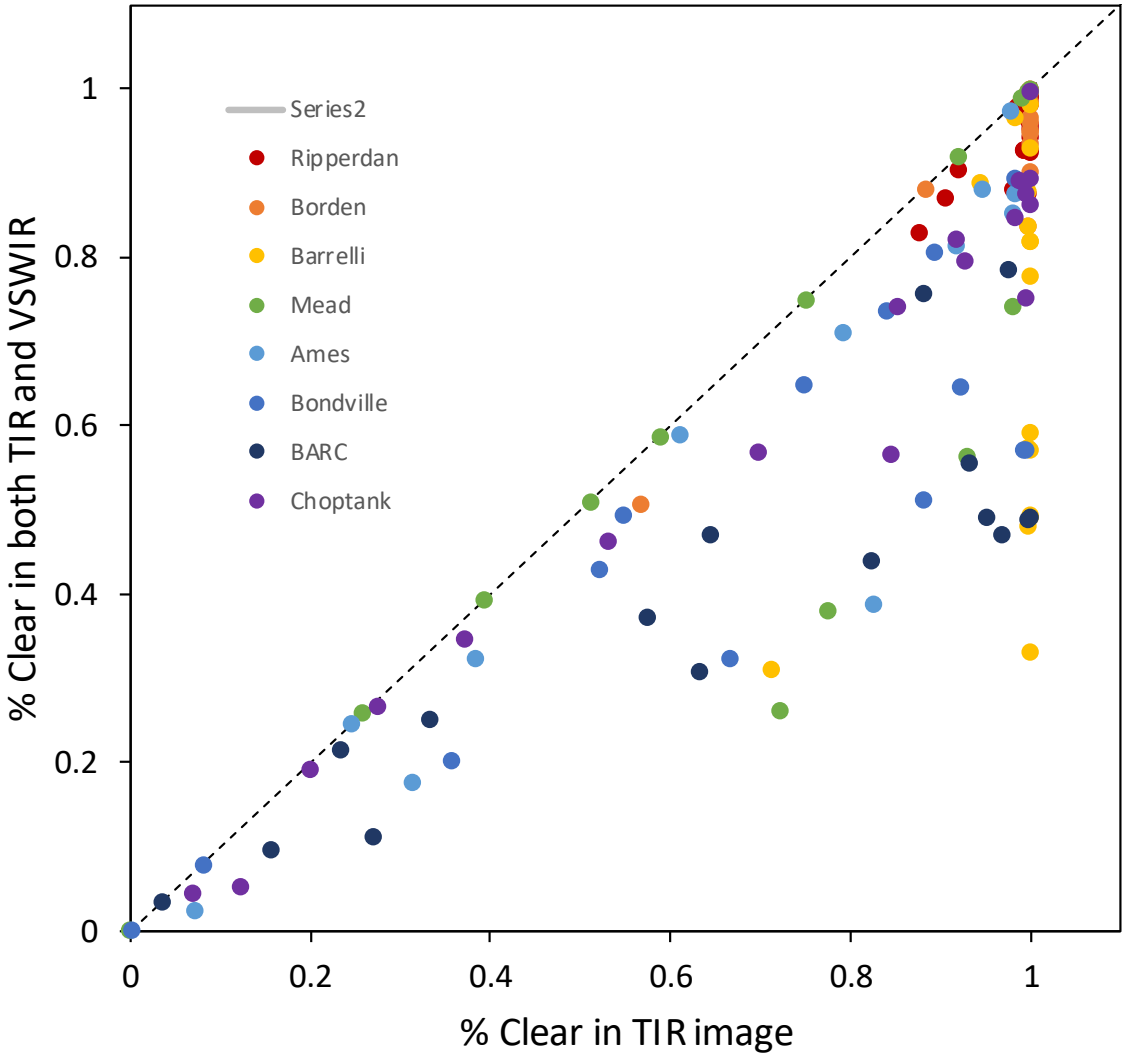
Most accurate retrievals with coincident TIR/VSWIR





ET GAP = UNION OF VSWIR AND LST GAPS

Impacts of TIR/VSWIR temporal offset



20% reduction on average in ET coverage

Conclusions

For operational ET monitoring

- consistent overpass time (min clouds, max contrast)
- consistent overpass frequency (< 4 days)
- consistent resolution/registration over image
  - ECOSTRESS view angle < 20°
- near-simultaneous TIR and VSWIR acquisition
- robust cloud/cloud shadow mask is critical
  - benefits from simultaneous TIR/VSWIR

USDA is an equal opportunity provider and employer.