Characterizing Field-scale Crop ET, Phenology and Productivity

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Multi-source Agricultural Monitoring

ASSETS *VNIR/TIR*

Coarse

- GOES
- MODIS
- VIIRS
- Landsat
- Sentinel2
- ECOSTRESS
- VENμS

Fine

TOOLS

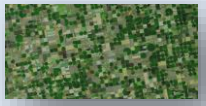
- Harmonize
- Sharpen
- Fusion

MODELS

- ALEXI ET
- Phenology
- Yield

PRODUCTS *(Daily/seasonal - 30 m)*

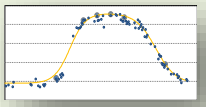
WATER



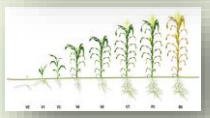
Evapotranspiration

Stress (ET/RefET)

CROPS

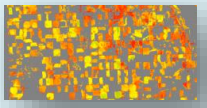


Vegetation index (NDVI, EVI2)

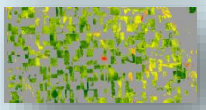


Phenology metrics

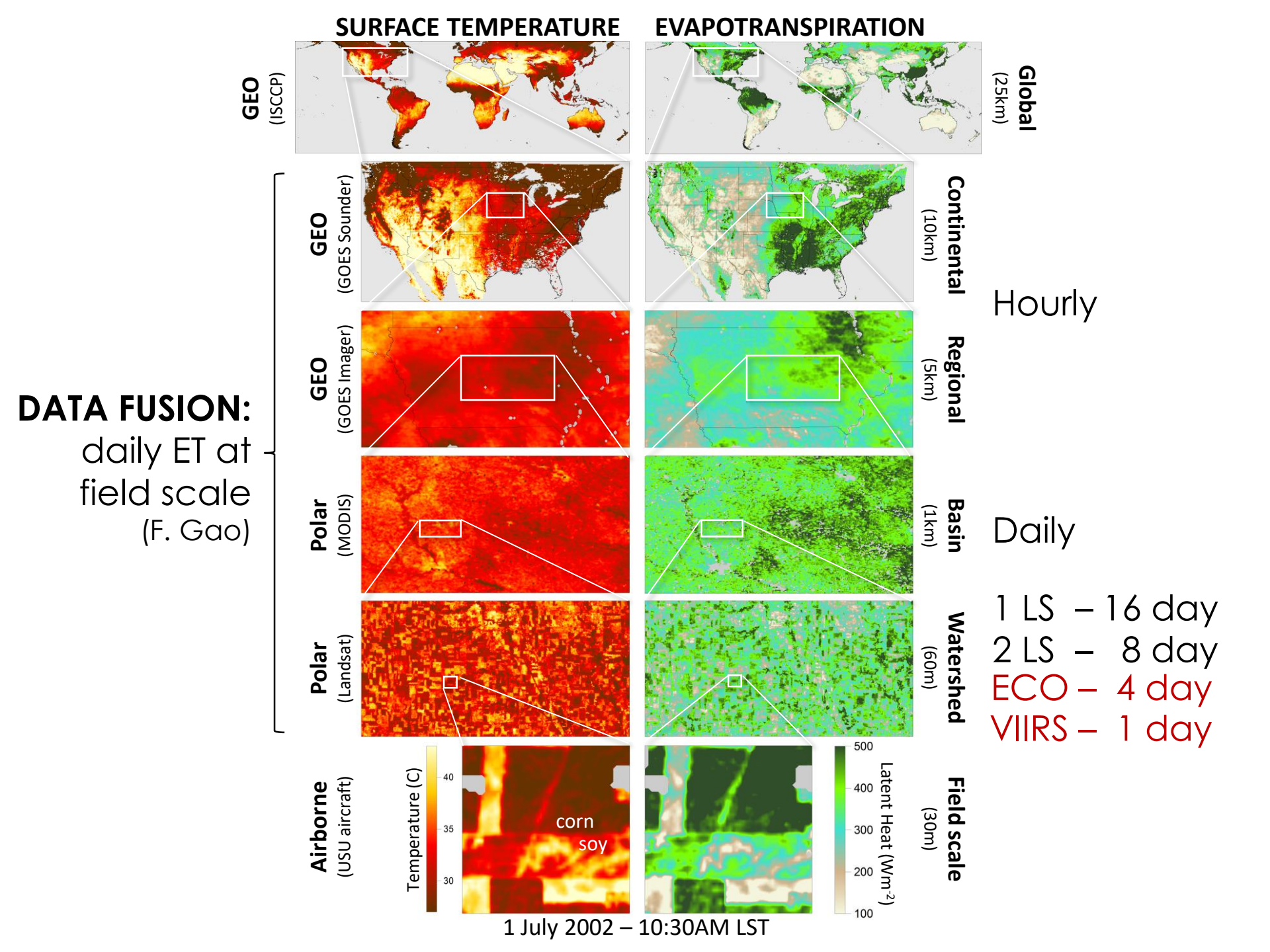
COMBINED



Yield estimates



Water productivity (crop per drop)

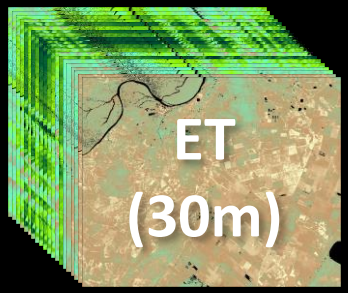

SURFACE TEMPERATURE
EVAPOTRANSPIRATION
GEO (ISCCP)
Global (25km)
GEO (GOES Sounder)
Continental (10km)
GEO (GOES Imager)
Regional (5km)
Polar (MODIS)
Basin (1km)
Polar (Landsat)
Watershed (60m)
Airborne (USU aircraft)
Field scale (30m)
Temperature (C)
40
35
30
corn
soy
500
400
300
200
100
Latent Heat (Wm-2)
1 July 2002 – 10:30AM LST
DATA FUSION:
daily ET at field scale
(F. Gao)
Hourly
Daily
1 LS – 16 day
2 LS – 8 day
ECO – 4 day
VIIRS – 1 day

Landsat 8

Launch 2/11/2013

Polar Orbit (16 day)
2 TIR bands (100 m)

VNIR from HLS-Landsat (30 m)

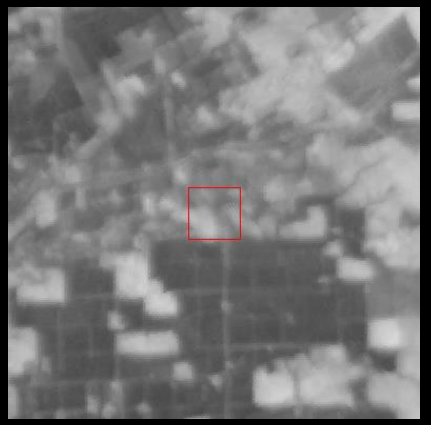


ECOSTRESS

Launch 6/29/2018

ISS Orbit (~4 day)
5 TIR bands (38x69 m)

VNIR from HLS+VIIRS fusion (30 m)

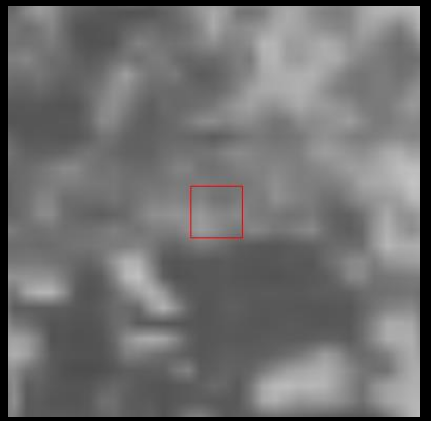


VIIRS

Launch 8/28/2011

Polar Orbit (~1 day)
I5 band (375 m)

VNIR from HLS-Sentinel 2 (30 m)



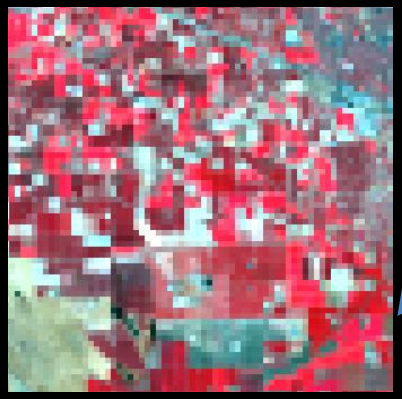
Data Mining Sharpener (DMS)

(Gao et al., 2012)

1 Select pure coarse TIR-SR samples. Build tree.

2 Apply tree to high resolution SR

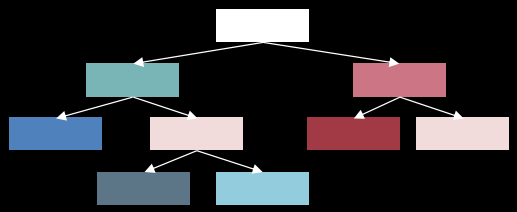
3 Conserve energy at coarse scale EC.

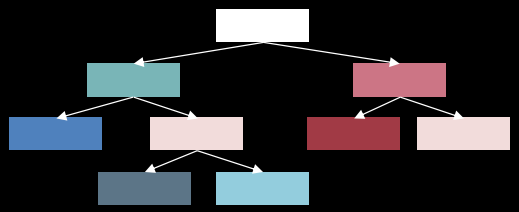


coarsen

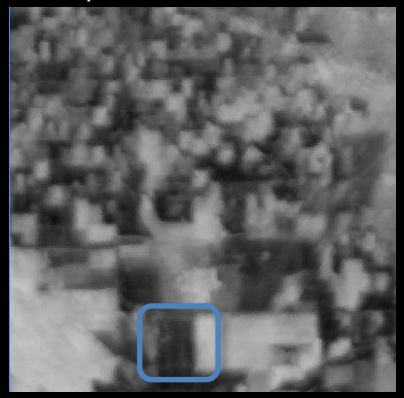
Difference

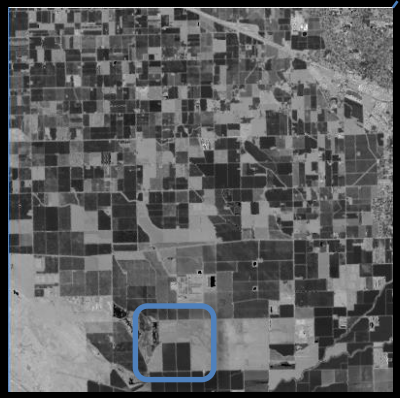
Landsat 8/29





ECO 8/24



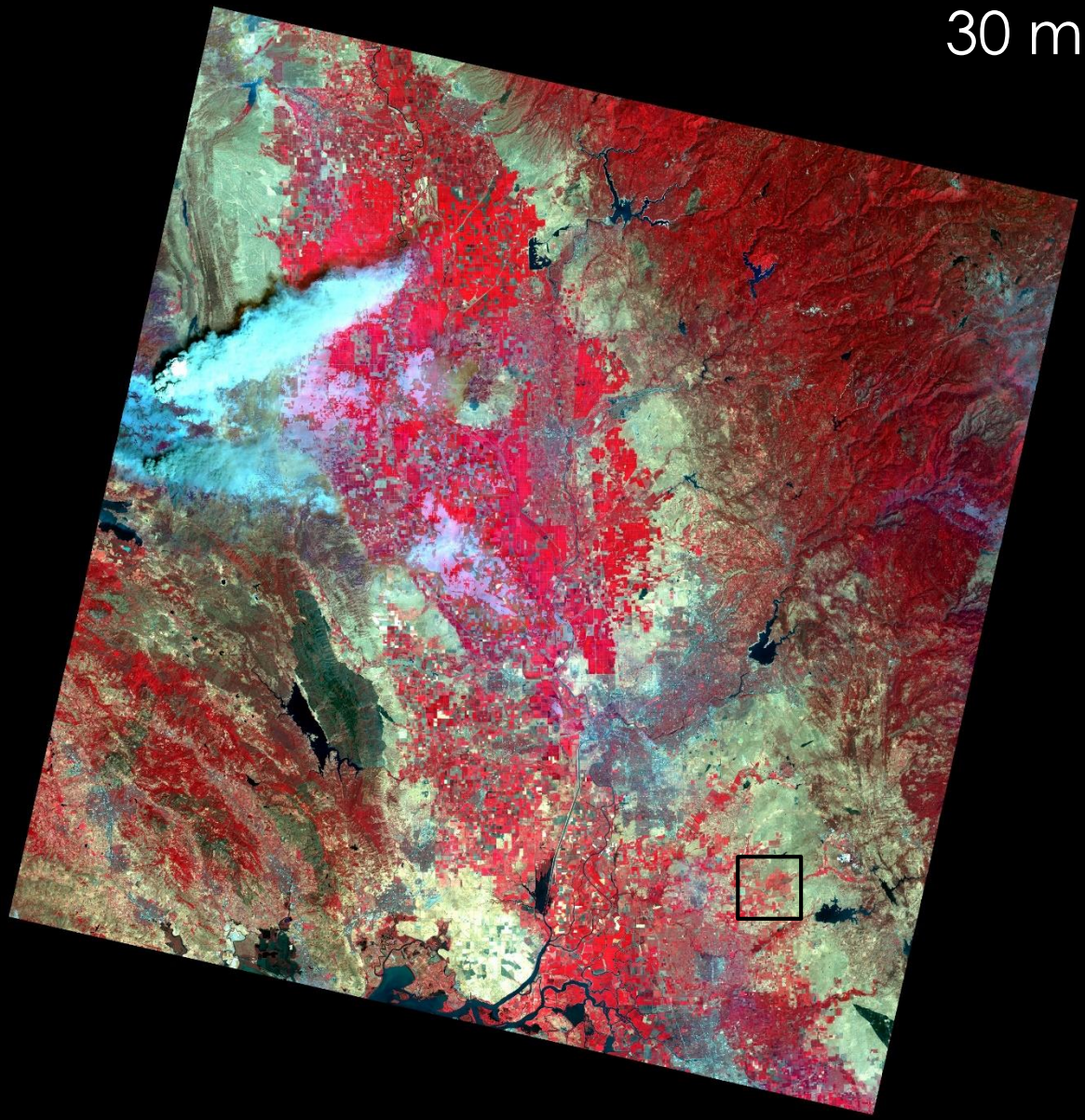


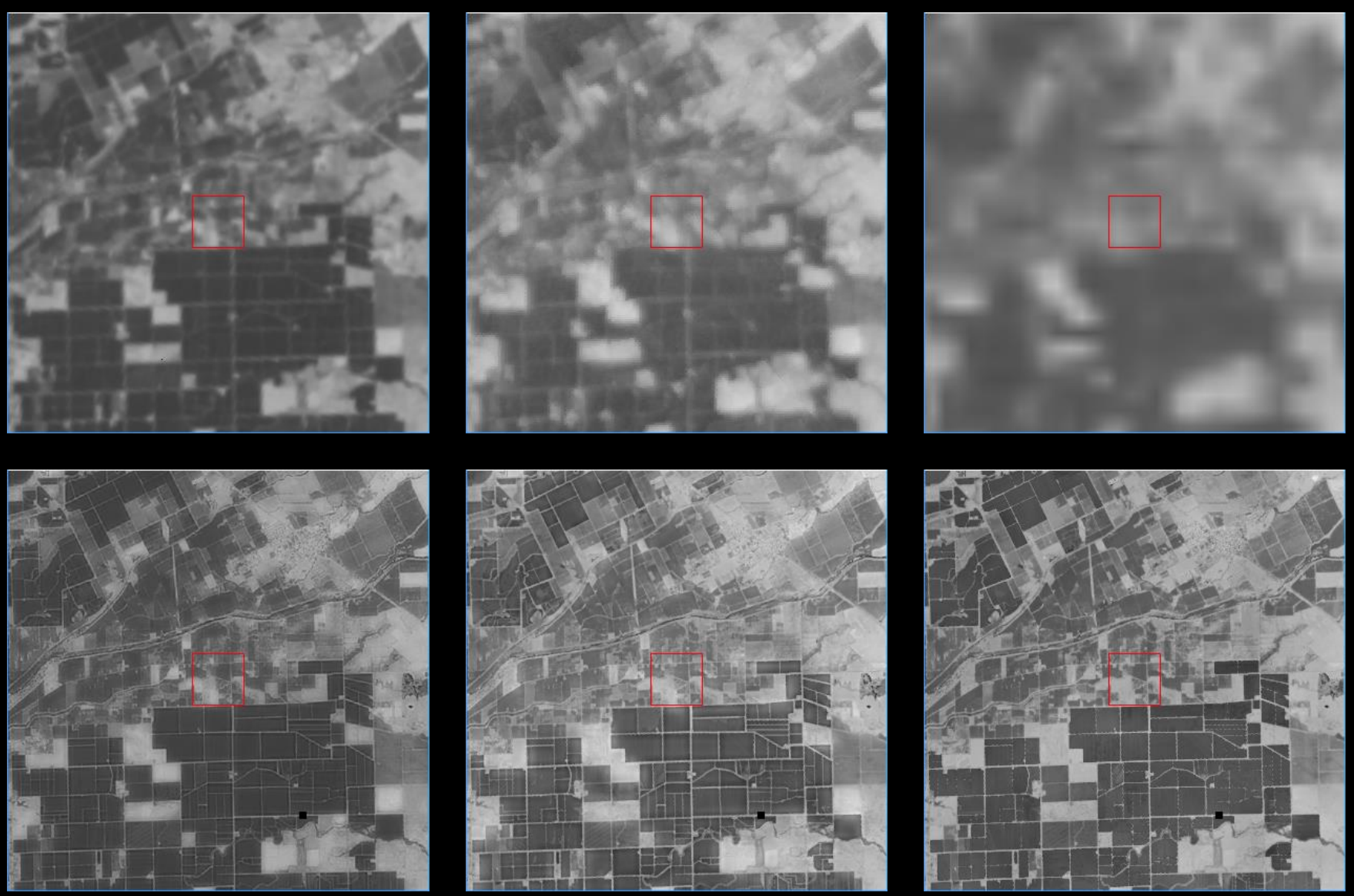
coarsen

Add residual

ECOSTRESS L2 LST 8/3/2018 (70 m)

L8 VNIR 8/3/2018
30 m

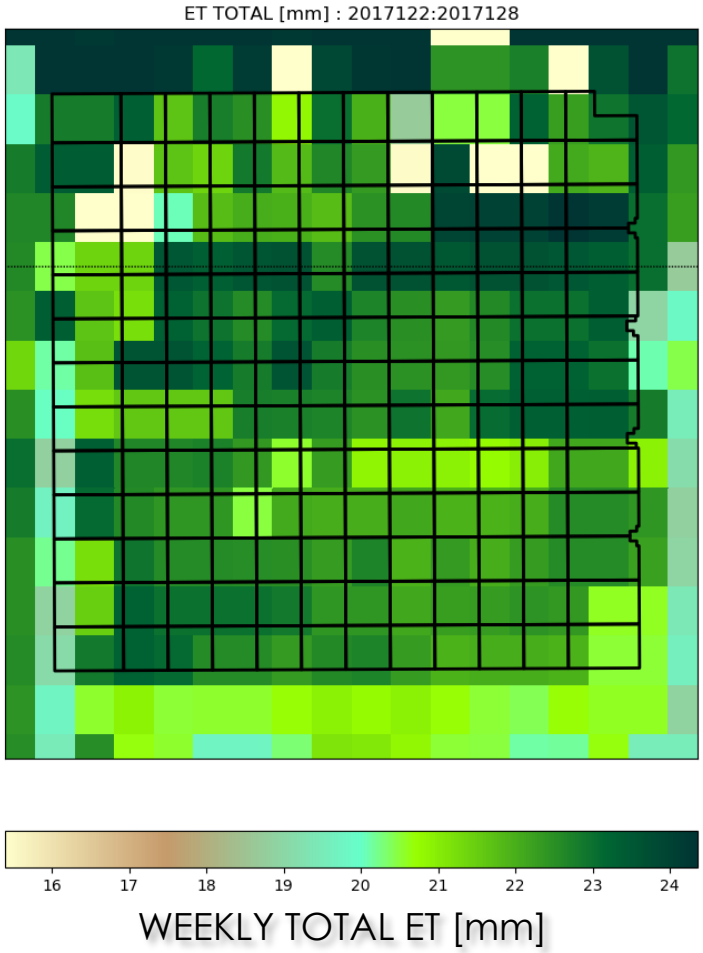



LANDSAT
ECOSTRESS
VIIRS
Native
Sharpened

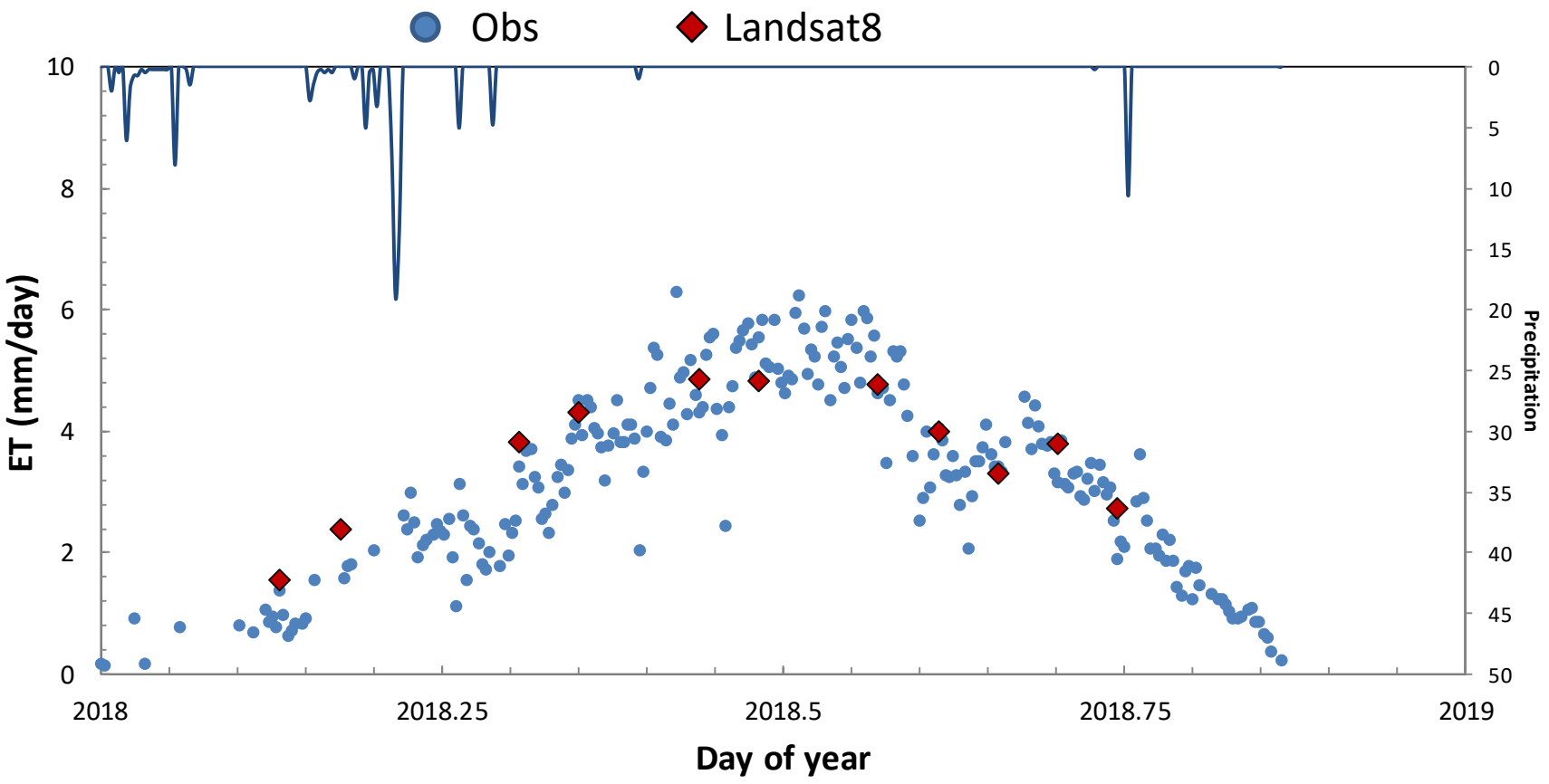
VARIABLE RATE DRIP IRRIGATION (VRDI)

Application: vineyard irrigation

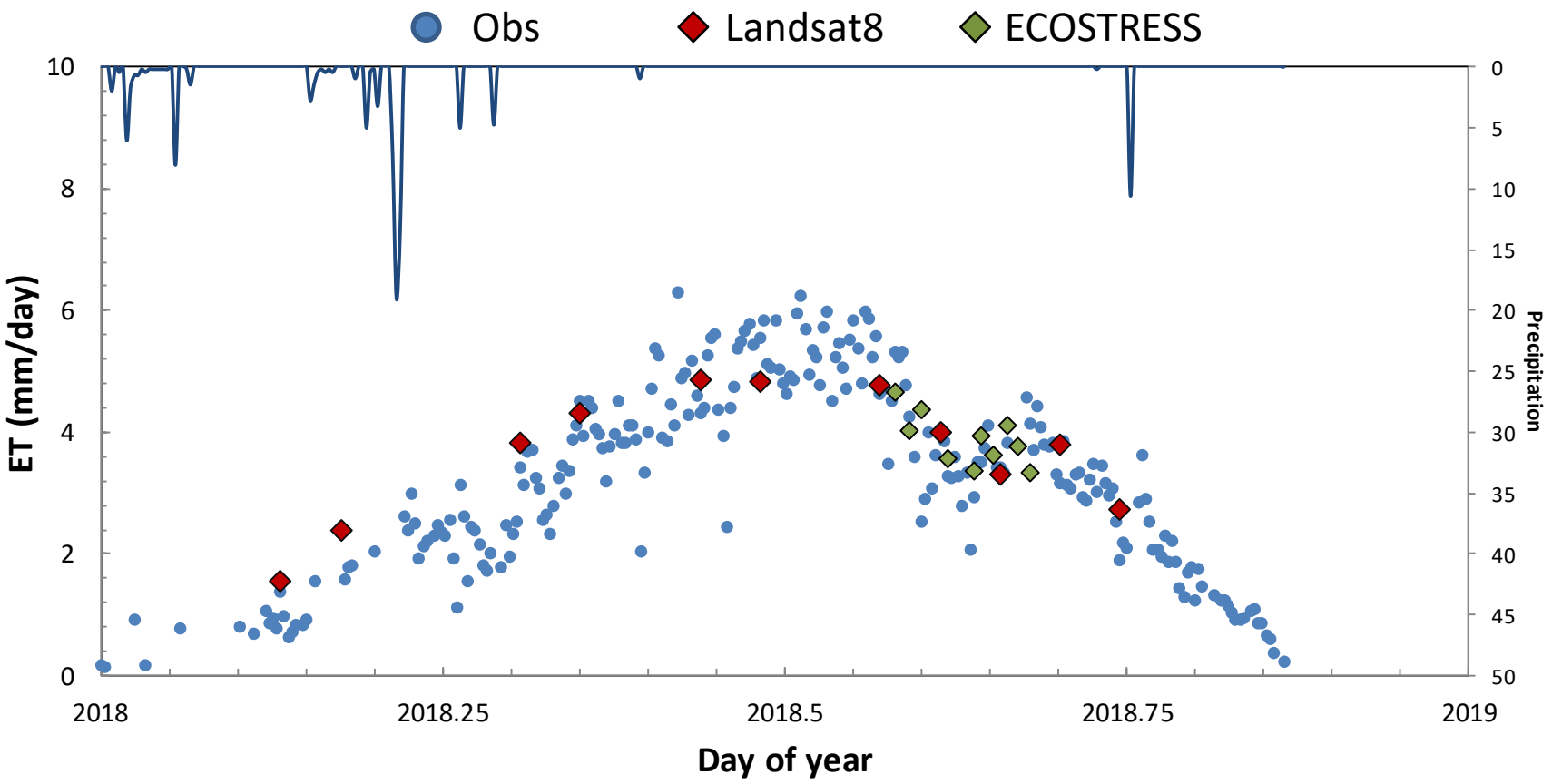
30x30m blocks with independent irrigation control



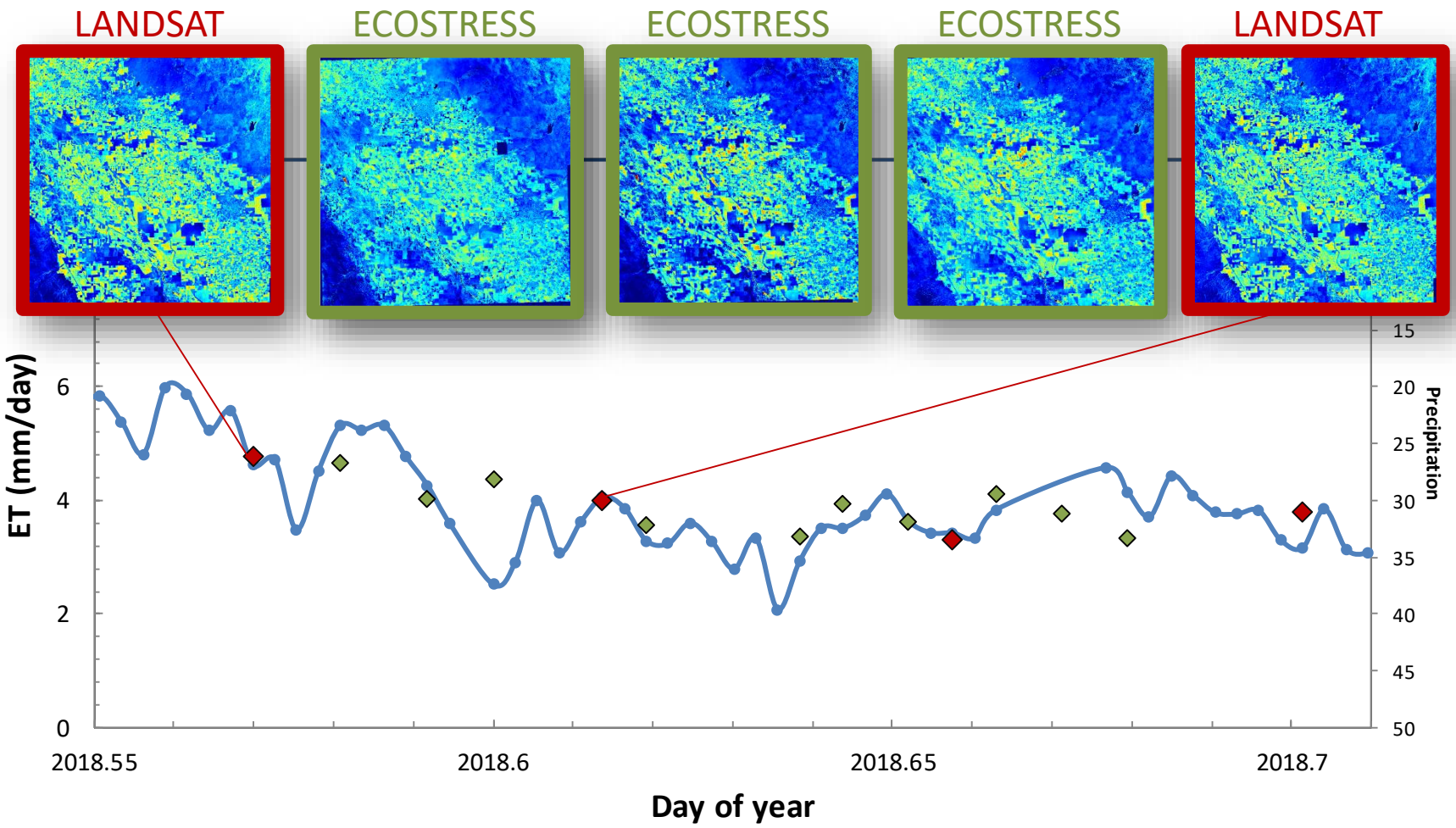
Application: vineyard irrigation



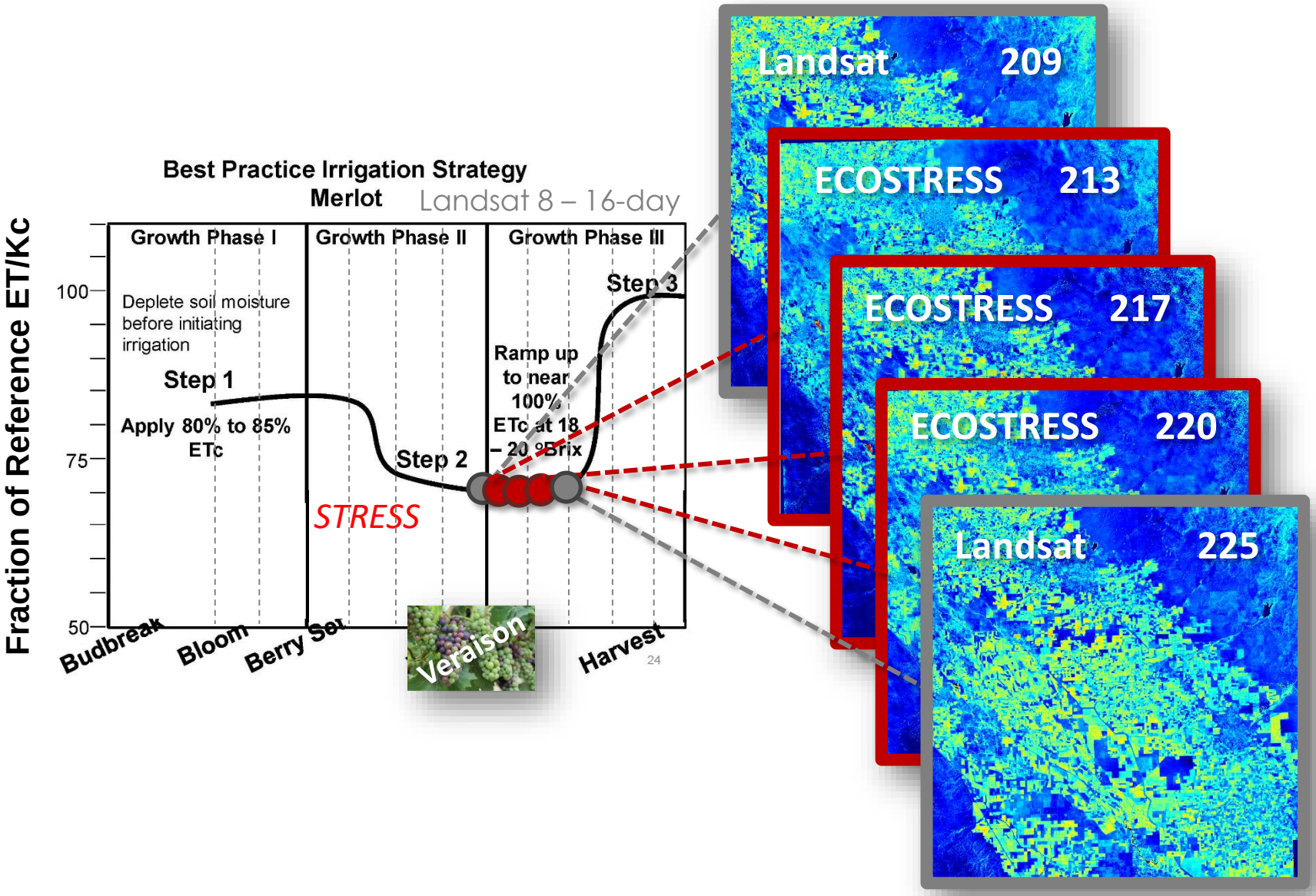
Application: vineyard irrigation

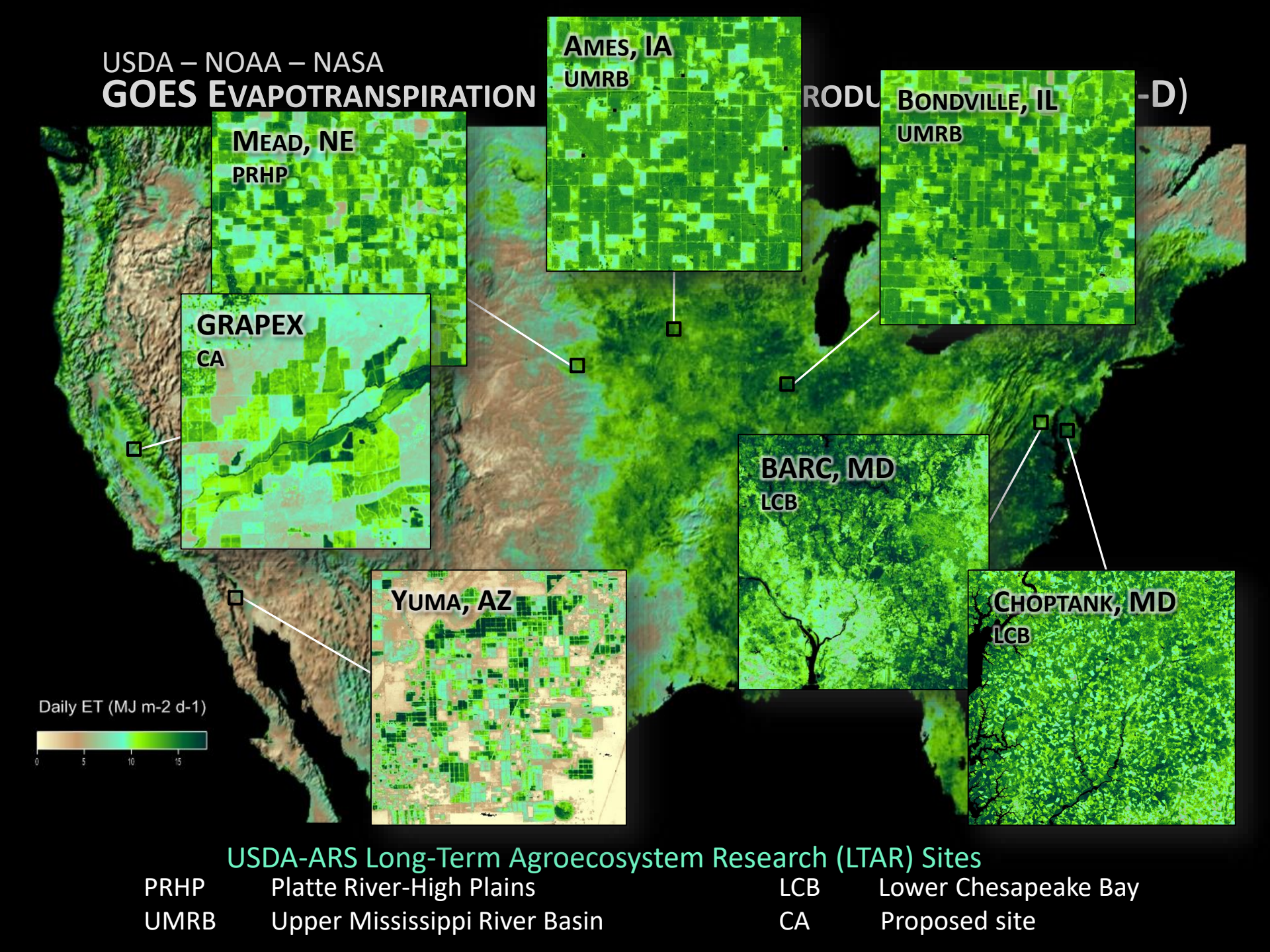


Application: vineyard irrigation



VARIABLE RATE DRIP IRRIGATION (VRDI)



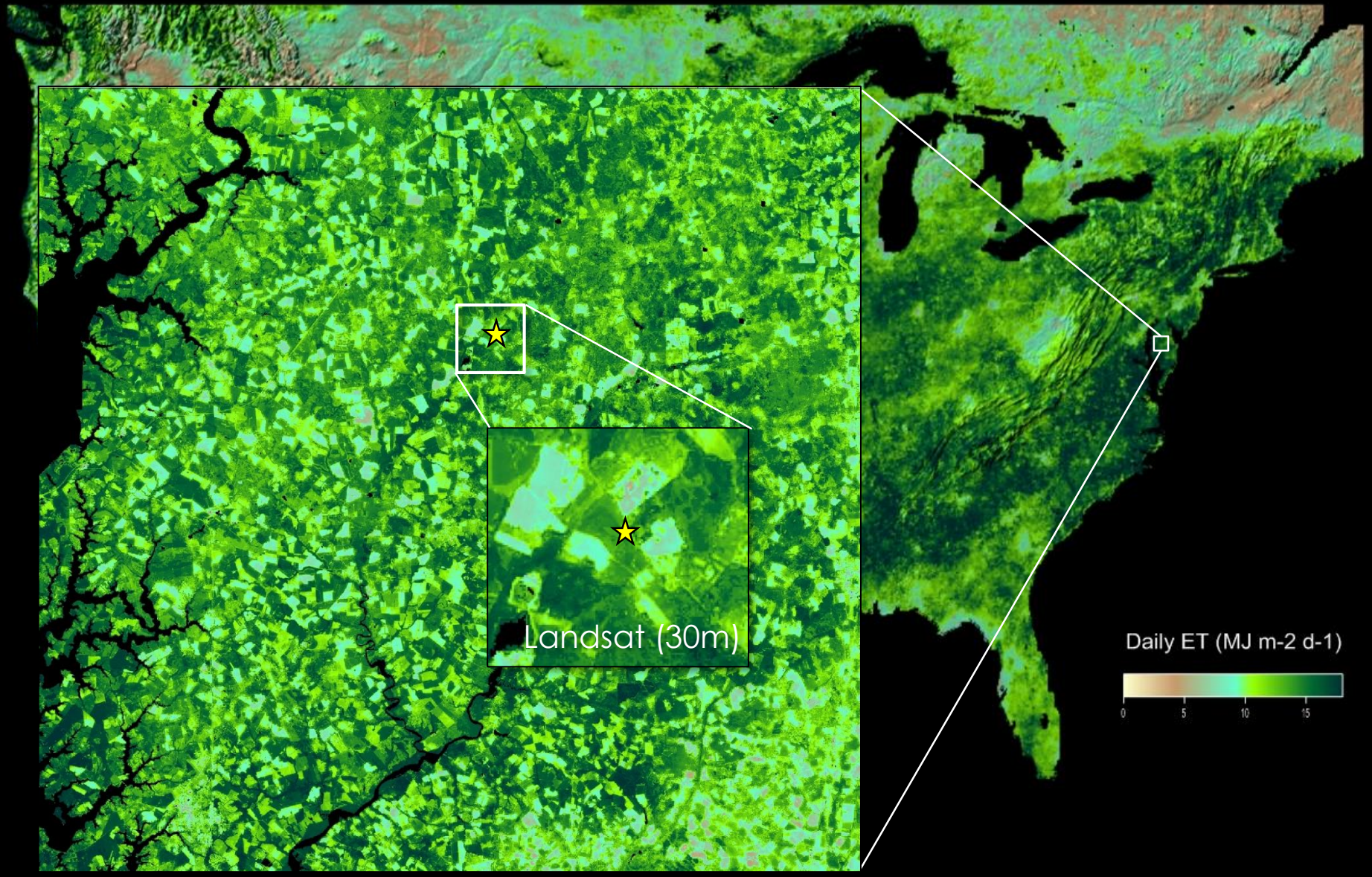


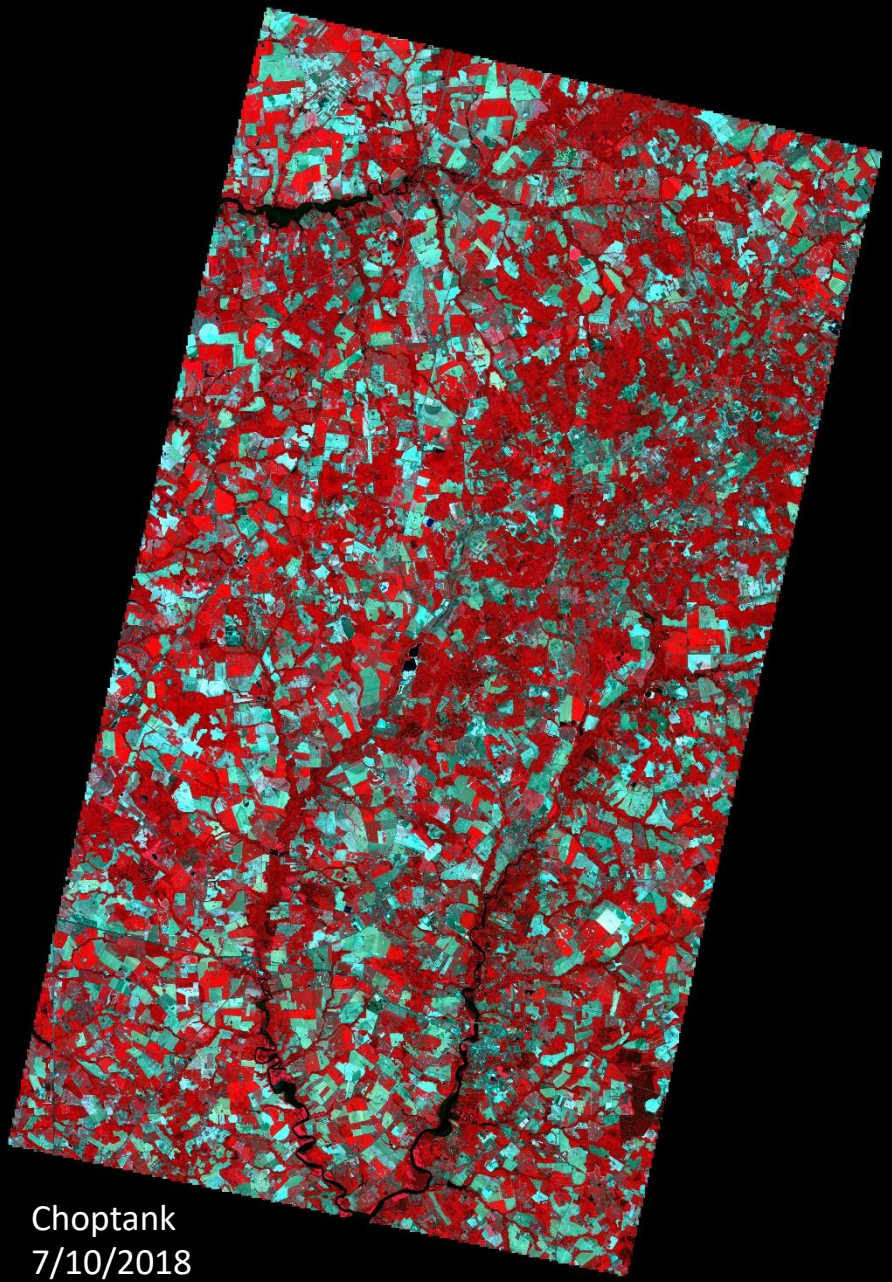
USDA-ARS Long-Term Agroecosystem Research (LTAR) Sites

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

USDA – NOAA – NASA

GOES Evapotranspiration and Drought Product System (GET-D)



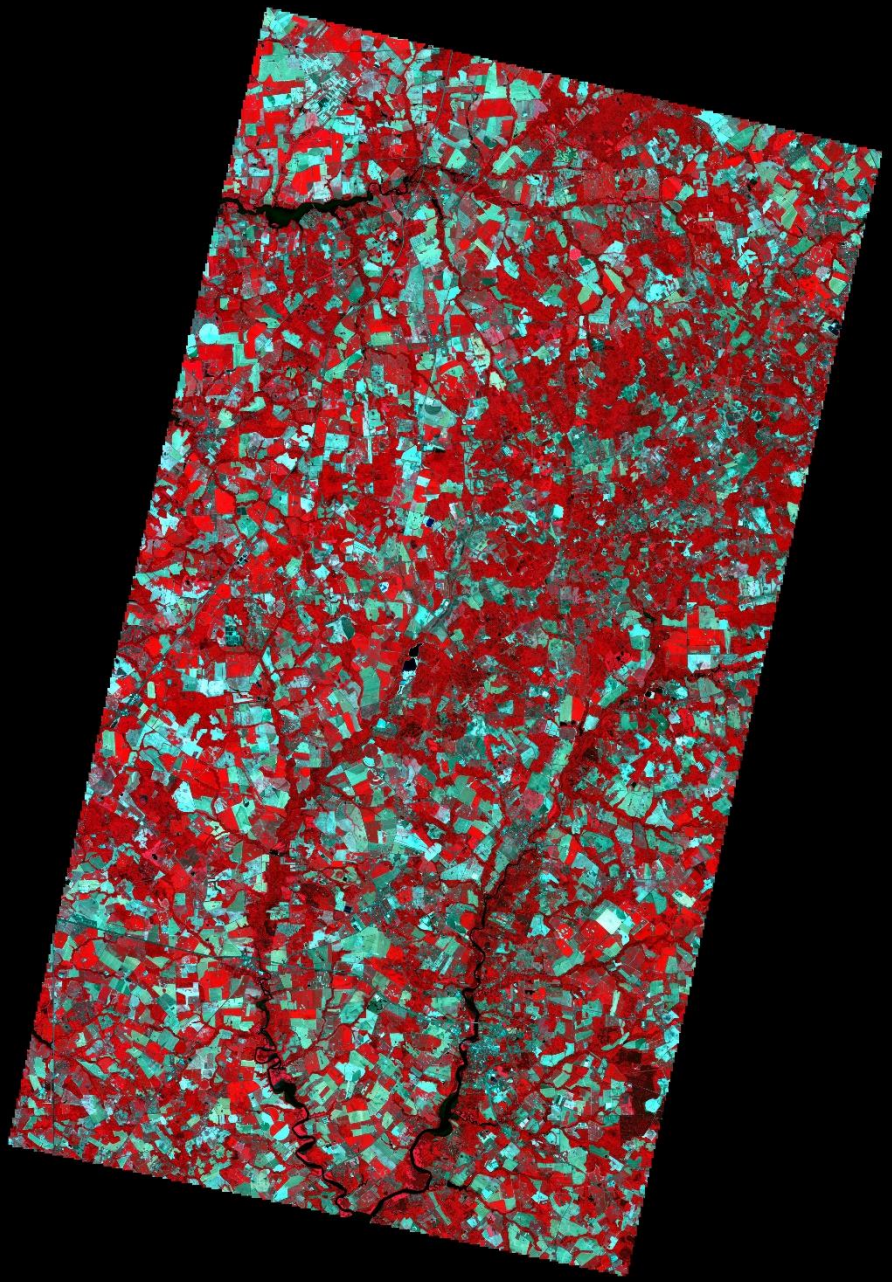


Choptank
7/10/2018

VENμS

Launch 2 August 2017
Israeli Space Agency & CNESS

Polar Orbit (2 day samples)
12 VNIR bands (5-10 m)



VENμS

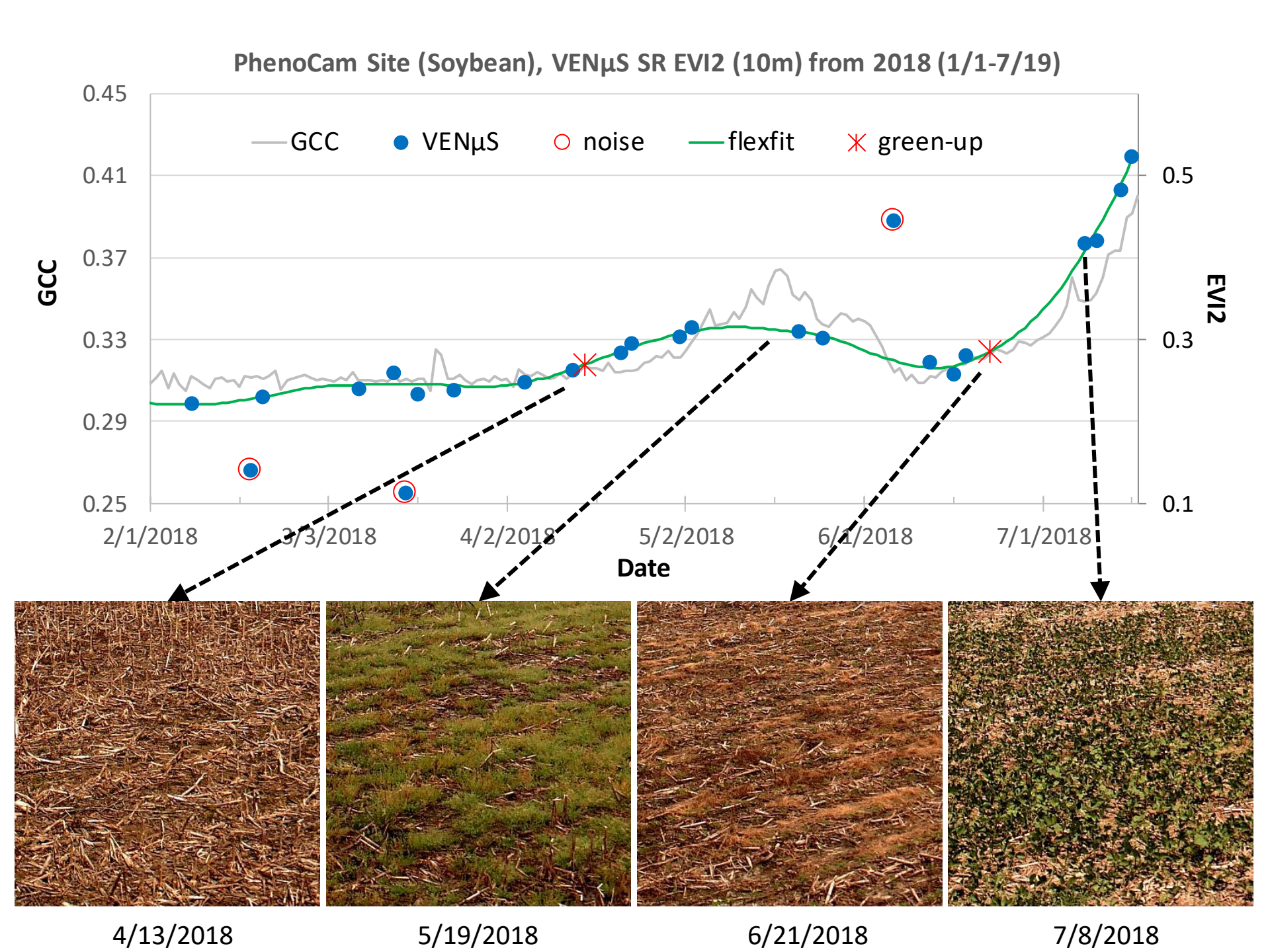
Launch 2 August 2017
Israeli Space Agency & CNESS

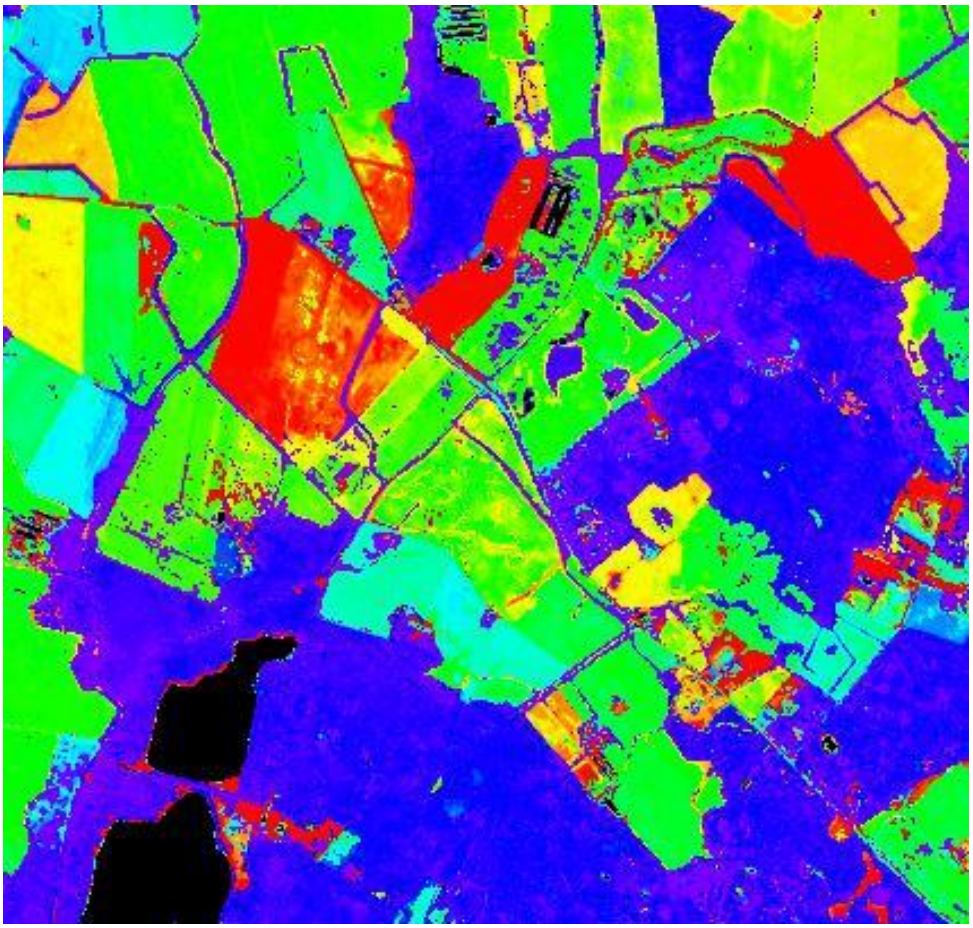
Polar Orbit (2 day samples)
12 VNIR bands (5-10 m)

Band	Band center (nm)	Bandwidth (nm)	Main objective
B1	420	40	Atmospheric correction
B2	443	40	Aerosols, clouds
B3	490	40	Atmos corr, water
B4	555	40	Land
B5	620	40	VIs
B6	620	40	DEM, image quality
B7	667	30	Red edge
B8	702	24	Red edge
B9	742	16	Red edge
B10	782	16	Red edge
B11	865	40	VIs
B12	910	20	Water vapor

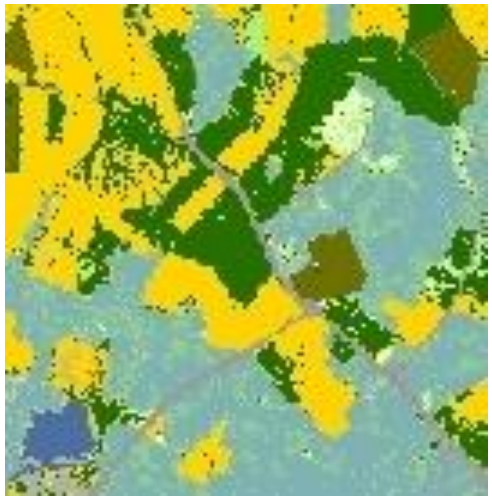
Mapping Crop Emergence using VENμS Imagery

- Crop emergence is a critical stage for crop development and crop growth modelling
- Challenges to map crop emergence using remote sensing
  - observations may not be sensitive to such small surface changes
  - early detection may be sensitive to spectral variations due to soil types and soil moisture
  - near real-time mapping requires frequent and up-to-date remote sensing observations
  - to identify crop phenology at field scales, routine and frequent remotely sensed data at Landsat 30-m or less spatial resolution are required


PhenoCam Site (Soybean), VENµS SR EVI2 (10m) from 2018 (1/1-7/19)
GCC
VENµS
noise
flexfit
green-up
0.45
0.41
0.37
0.33
0.29
0.25
GCC
0.5
0.3
0.1
EVI2
2/1/2018
3/3/2018
4/2/2018
5/2/2018
6/1/2018
7/1/2018
Date
4/13/2018
5/19/2018
6/21/2018
7/8/2018



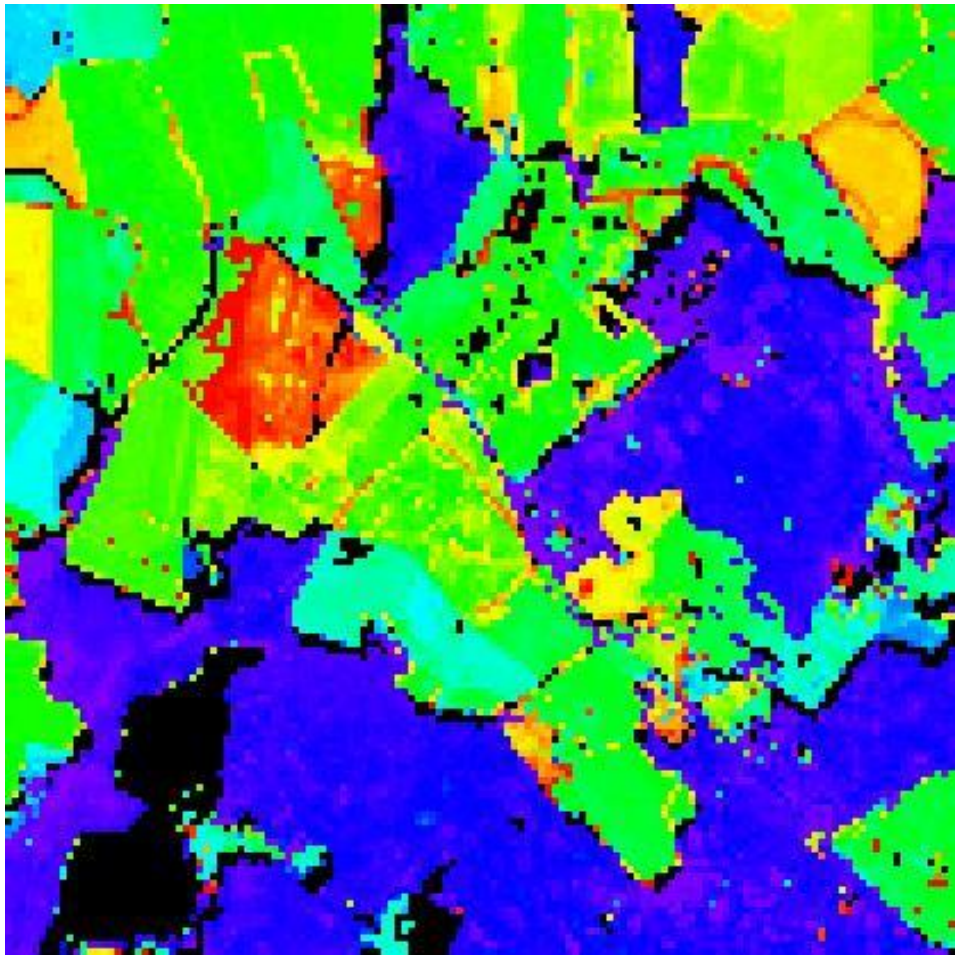
Green-up dates using VENµS 10m L2 data acquired from 1/1/2018 to 9/9/2018



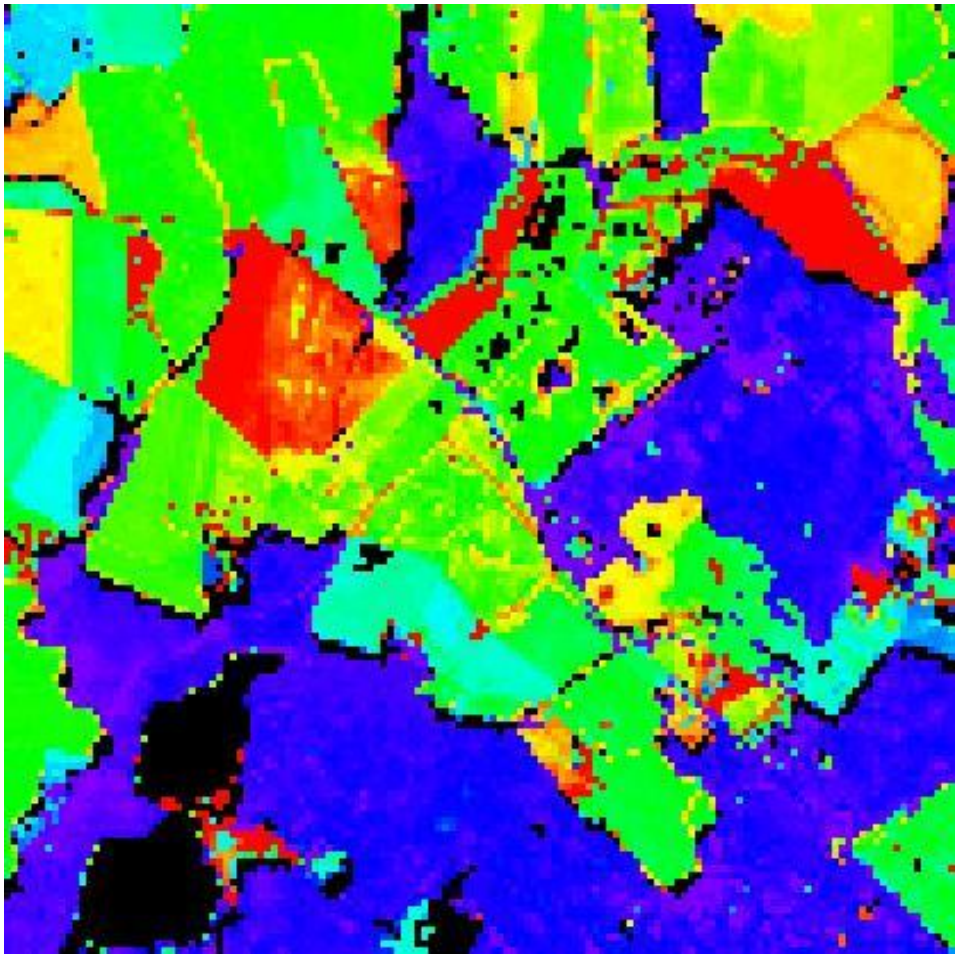
Cropland Data Layer

- Corn
- Soybeans
- Woody wetlands
- Winter wheat/soy

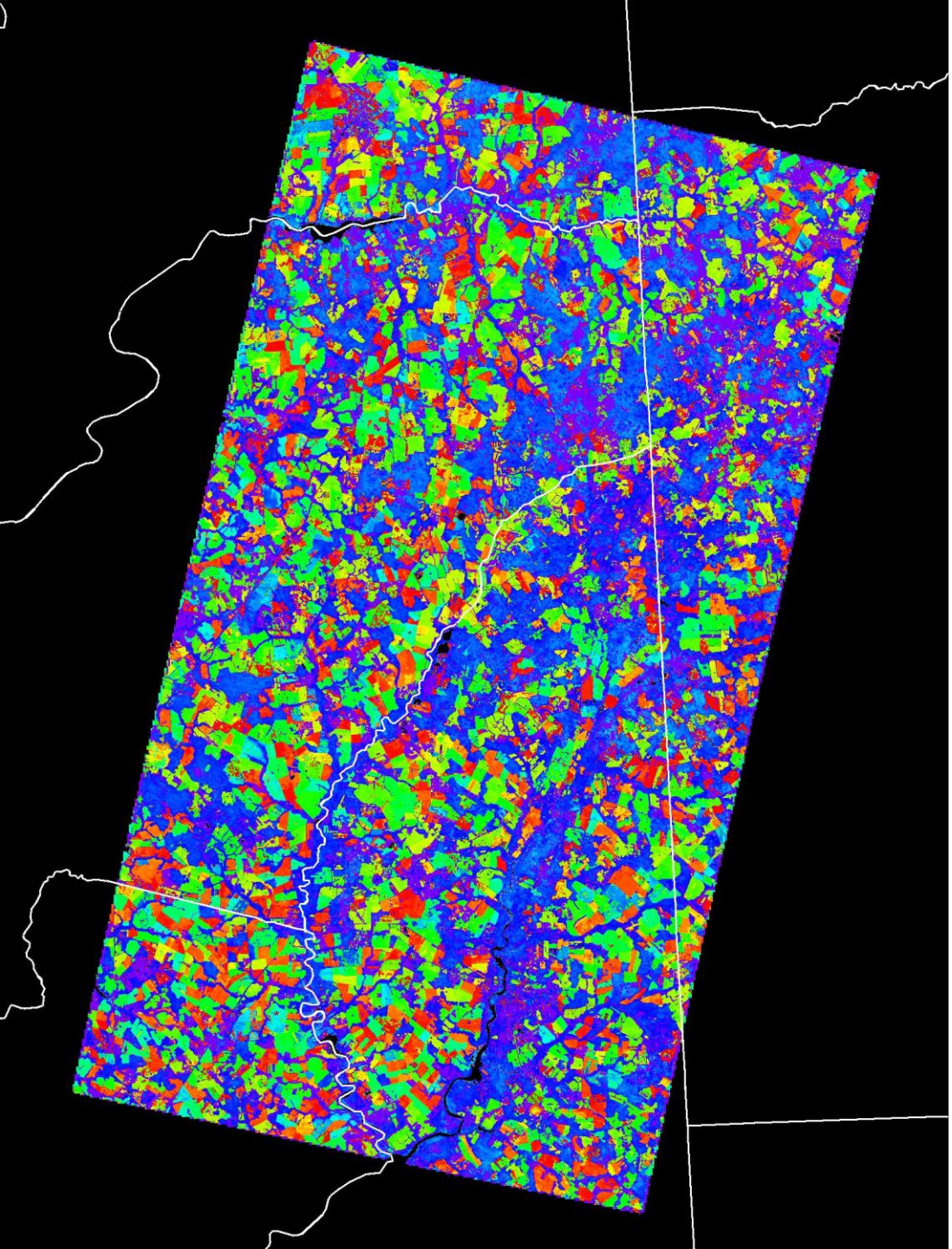
Results (30m) using Different Date Ranges as Input

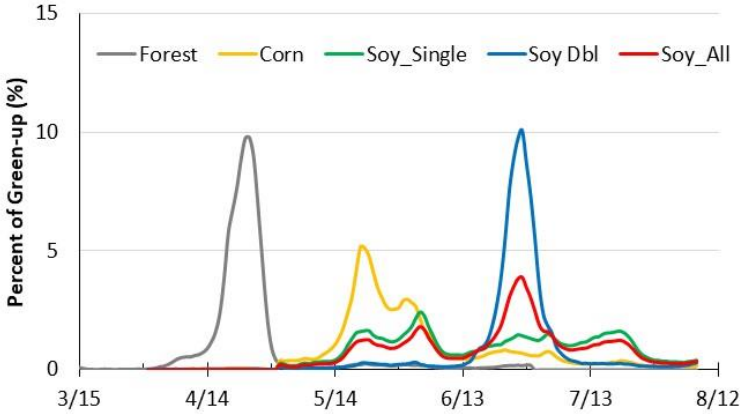


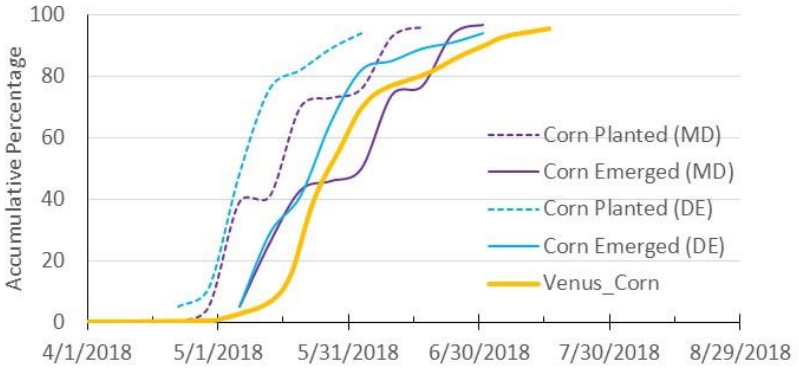
Based on VENµS (1/1 - 7/19)



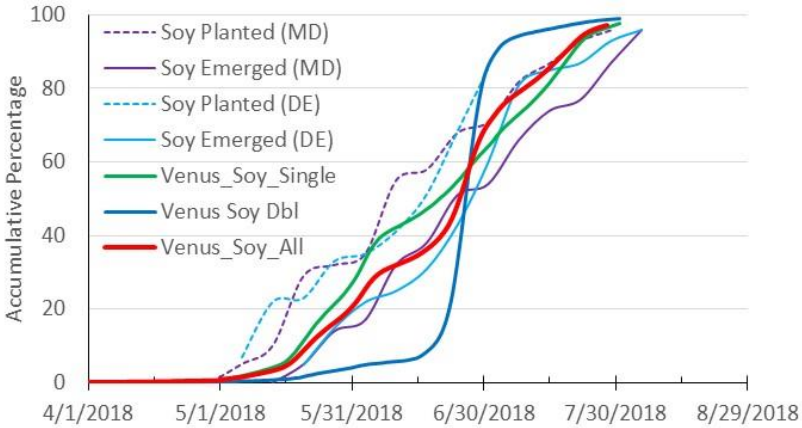
Based on VENµS (1/1 – 9/9)





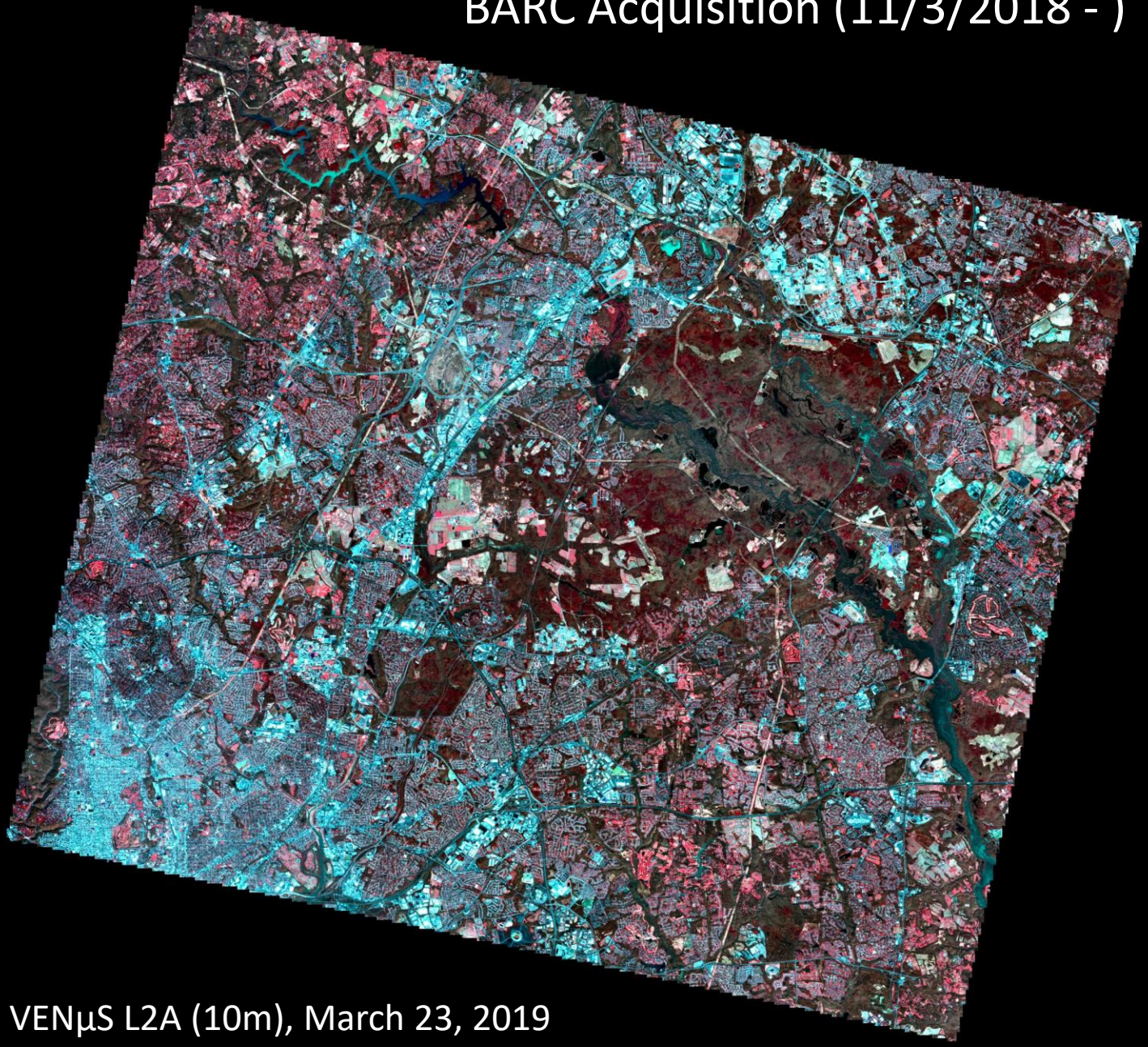


VENµS green-up dates vs. NASS corn progress



VENµS green-up dates vs. NASS soybean progress

BARC Acquisition (11/3/2018 -)



VENµS L2A (10m), March 23, 2019